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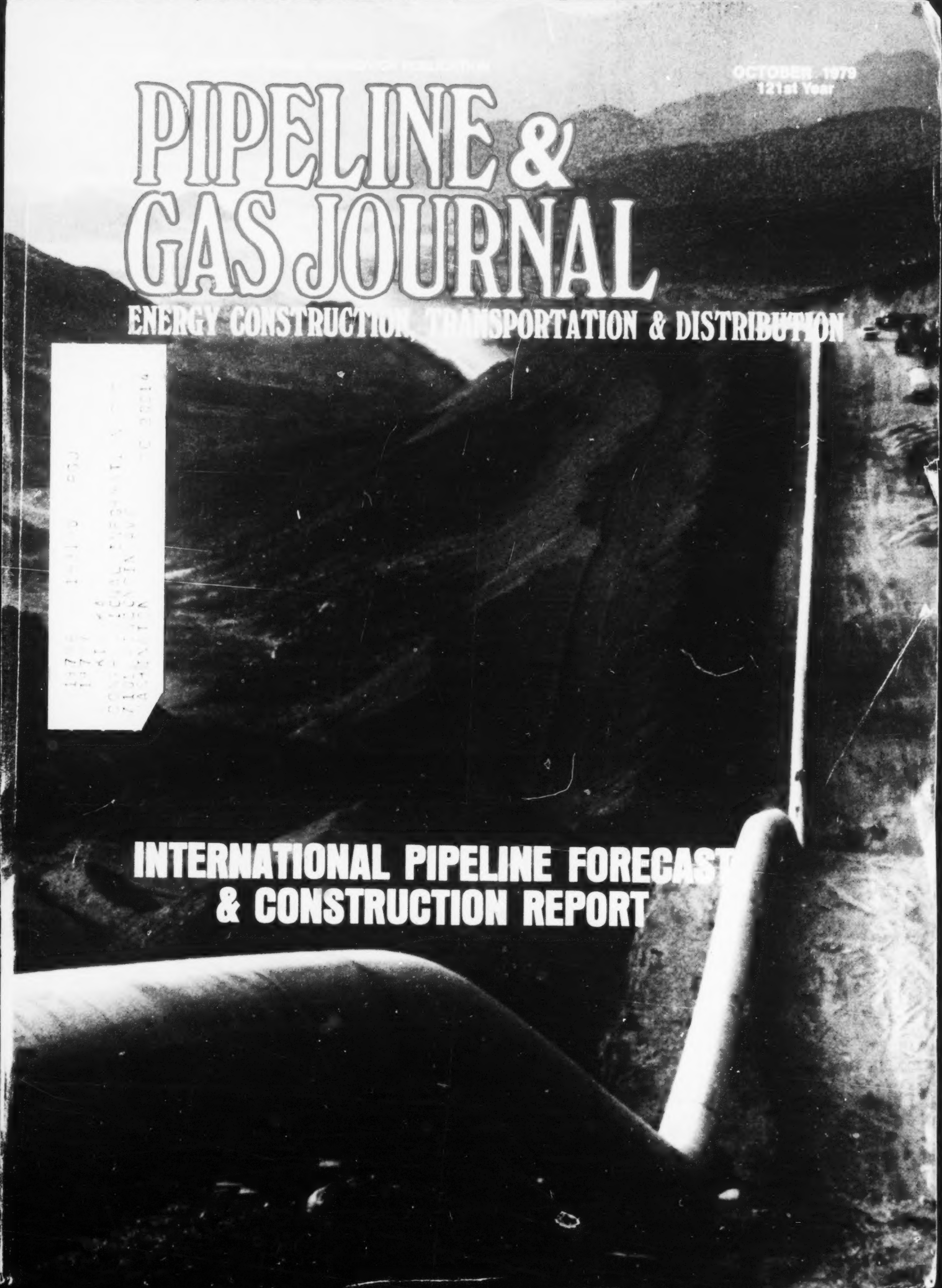

INTERNATIONAL PIPELINE FORECAST & CONSTRUCTION REPORT

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THE COVER

Working across western Saudi Arabia's Hejaz mountain region, pipeliners joint the 48-in. Petroline oil line on its way from eastern fields to the new terminal at Yanbu.

—Photo courtesy CAT-Houston

World Pipeline Construction, Planning, Tops 100,000 Miles 19
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Five underwater lines installed from seaberth to central terminal station on Okinawa included 56- and 44-in. oil lines, 30-in. ballast line, and two smaller pipe sections; NKK's *Kokan Pioneer I* laid the system in three groups.

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British Gas Corp.'s new 42-in. epoxy coated pipe test section points out advantages to contractors—including faster laying rates, improved cost economics, and ensured health and safety.

U-Gas Plant Planned For Memphis 70
New method of converting coal to high-Btu gas that employs a simple design and safe, reliable operation will be used in demonstration plant planned for Shelby County, Tenn., under sponsorship of Memphis Light, Gas and Water, and Department of Energy.

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World Pipeline Construction Planning Tops 100,000 Miles

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by Dean Hale, *Editor*

Over $110 billion will be spent to build more than 100,000 miles of pipelines now planned or underway around the world (outside the United States), according to PIPELINE & GAS JOURNAL's survey of the world pipeline scene. As of September, 1979, there were 100,597 miles of natural gas, crude oil, refined products, and slurry pipelines either planned or actually under construction. Excluding 5867 miles of such pipelines in Iran, the world total is 94,730 miles. The total includes 18,212 miles of pipelines in the U.S.S.R., the Eastern Bloc countries, and the Peoples Republic of China.

Total mileage of planned and underway lines (excluding the U.S.S.R., Eastern Bloc and China lines) is up 5.7% over comparable 1978 figures, while total miles of lines under construction are down 18.5%. Interestingly, total mileage of lines planned and underway in the U.S.S.R. are also down by nearly 20%. Approximately 47% of the U.S.S.R.-Eastern Bloc-China lines are under construction while the figure is only 25% for all other international pipelines.

Natural gas lines account for 54.7% of the total international pipelines — 51,859 miles, with 9636 miles underway and 42,223 miles planned. Crude oil pipelines account for another 25.5% with 24,141 miles total and 9380 miles under construction. Products pipelines represent 17.5% with 16,504 miles total and 6836 miles being built.

Europe leads all areas with a total 17,594 miles of pipelines and 3386 miles under construction. The Middle East, which has been the hot spot for pipeline construction and planning in recent years, has a total of 16,960 miles of lines planned or underway — with 6335 miles actually being built. For Africa, a total of 9110 miles is on the books, with 3900 miles being installed. Central America and Mexico is an extremely active area — considering the region's size — with 4149 miles total and 2051 miles underway. A total of 4921 miles of pipeline planned or underway is recorded for Australia and New Zealand, with current construction totaling only 120 miles. The Southeast Asia/Pacific area totals 5629 miles, with 2769 miles being built. In South America, the 1050 miles of pipelines being installed represent only about 10% of the total 10,055 miles of planned/underway pipeline activity. And Canada, with 13,967 miles planned or underway, has a bright future even though there are only 1302 miles of pipeline currently being built.

The U.S.S.R., according to currently available information, has 12,231 miles planned/underway, with 6185 miles of pipelines under construction and with much of it to be completed in 1979 or very early 1980. The Eastern Bloc countries — Poland, Hungary, Bulgaria, Czechoslovakia, and Yugoslavia — represent 3191 total miles and 2360 miles underway. China, which is in urgent need of pipelines (see special report this issue), has plans for 3320 miles of oil and gas pipelines but nothing concrete for near future construction.

Some big projects are underway across the globe, keeping international pipeline construction firms busy, including the 787 mile, 48-in. Petroline oil pipeline across Saudi Arabia (see special report this issue), which is being paralleled by a 746 mile, 28/30-in. natural gas liquids line being built for Aramco Services Co. The Trans-Mediterranean Gas Pipeline got underway with a bang in 1979, with construction crews busy in

INTERNATIONAL PIPELINE CONSTRUCTION — BY TYPE OF LINE

(As of September 1979)

	Miles		
Type of Line	**Total***	**U/C***	**Planned***
Gas	51,859	9,636	42,223
Crude	22,091	9,380	12,711
Products	16,504	6,836	9,668
Slurry	2,226	—	2,226
TOTALS	92,320	25,852	66,468
Iran*	5,867*	3,606**	2,684*
Grand Totals	**98,547**	**28,918**	**69,152**

*(*All pipeline construction in Iran suspended; not included in totals by types of line)*

INTERNATIONAL PIPELINE CONSTRUCTION — BY COUNTRY

(Underway, Planned, and Proposed – September 1979) In Miles

	Miles of Gas Pipelines		Miles of Crude Oil Pipelines		Miles of Product Pipelines		Miles of Slurry Pipelines		Total Miles	
	+Total	Underway	Total	Underway	Total	Underway	Total	Underway	Total	Underway
Abu Dhabi	515	99	720	—	—	—	—	—	1235	99
Algeria	3829	965	1095	1095	596	596	—	—	5520	2656
Argentina	2127	—	—	—	12	—	—	—	2139	—
Australia	2093	24	24	—	2375	39	168	—	4660	63
Austria	226	226	—	—	—	—	—	—	226	226
Bangladesh	122	—	—	—	—	—	—	—	122	—
Belgium	109	—	—	—	93	93	—	—	202	93
Bolivia	2495	—	161	161	536	—	—	—	3192	161
Brazil	58	40	1425	645	302	—	9	—	1794	685
Bulgaria	247	247	—	—	—	—	—	—	247	247
Cameroon	—	—	2	—	—	—	—	—	2	—
Canada	10226	1129	2459	91	1282	82	—	—	13967	1302
Chad	—	—	210	210	—	—	—	—	210	210
Chile	694	—	10	—	—	—	46	—	750	—
China	1200	—	2120	—	—	—	—	—	3320	—
Colombia	548	—	1048	—	295	—	—	—	1891	—
Congo	—	—	14	—	—	—	—	—	14	—
Costa Rica	—	—	—	—	30	30	—	—	30	30
Czechoslovakia	536	536	61	61	—	—	—	—	597	597
Denmark	9308	—	—	—	—	—	—	—	9308	—
Dubai	—	—	17	—	—	—	—	—	17	—
Ecuador	316	—	6	—	505	355	—	—	827	355
Egypt	180	—	224	224	23	23	—	—	427	247
France	930	—	682	288	81	—	—	—	1693	288
Greece	70	—	50	—	—	—	—	—	120	—
Guatemala	—	—	277	—	—	—	—	—	277	—
Hungary	—	—	112	—	188	—	—	—	300	—
India	—	—	1095	504	300	—	171	—	1566	504
Indonesia	100	100	162	100	—	—	—	—	262	200
Iran	3441*	—	363*	—	2063*	1996*	—	—	5867*	3606*
Iraq	683	—	1322	—	185	—	—	—	2190	—
Ireland	—	—	—	—	—	—	—	—	—	—
Italy	967	602	—	—	67	—	342	—	1376	602
Ivory Coast	—	—	12	12	—	—	—	—	12	12
Japan	1080	—	—	—	—	—	—	—	1080	—
Kuwait	—	—	400	400	373	350	—	—	773	750
Libya	—	—	1168	436	—	—	—	—	1168	436
Malaysia	—	—	230	150	—	—	—	—	230	150
Mexico	969	666	554	554	1456	446	—	—	2979	1666
Netherlands	6	—	—	—	100	—	—	—	106	—
New Zealand	261	57	—	—	100	—	—	—	361	57
Nigeria	—	—	100	25	—	—	—	—	100	25
Norway	600	—	—	—	—	—	—	—	600	—
Oman	140	—	947	280	—	—	—	—	1087	280
Pakistan	663	—	538	390	525	525	—	—	1726	915
Panama	—	—	36	—	—	—	—	—	36	—
Peru	—	—	160	160	—	—	—	—	160	160
Poland	—	—	—	—	88	88	—	—	88	88
Portugal	—	—	—	—	69	—	—	—	69	—
Saudi Arabia	169	9	2191	838	2262	1324	—	—	4622	2171
South Africa	—	—	—	—	90	90	—	—	90	90
Spain	538	538	68	—	431	431	—	—	1037	969
Sweden	186	—	—	—	—	—	—	—	186	—
Switzerland	74	74	288	288	—	—	—	—	362	362
Tanzania	—	—	—	—	678	—	—	—	678	—
Thailand	275	—	134	—	234	—	—	—	643	—
Tunisia	304	224	—	—	—	—	—	—	304	224
Turkey	108	—	274	—	—	—	—	—	382	—
United Kingdom	447	132	263	171	355	155	—	—	1065	458
USSR	6105	4105	580	580	2006	1500	1490	—	10181	6185
Venezuela	85	—	—	—	44	44	—	—	129	44
W. Germany	1027	388	294	—	15	—	—	—	1336	388
Yemen	—	—	374	374	—	—	—	—	374	374
Yugoslavia	1253	722	706	706	—	—	—	—	1959	1428
Zaire	—	—	—	—	205	—	—	—	205	—
Zambia	—	—	—	—	380	—	—	—	380	—
Grand Total	**55300**	**10883**	**22091**	**9743**	**18567**	**8832**	**2226**	**—**	**98547**	**28918****

+ Total indicates all planned lines plus lines under construction at survey time.
** Includes 5867 miles of Iranian lines of unknown status.*
*** Includes 3606 miles of Iranian lines of unknown status.*

Automatic welding equipment, mounted on half-tracks for mobility in desert sand, makes up the firing line on the Aramco Services 746-mile, 28/30-in. natural gas liquids line being built across Saudi Arabia.

Algeria, Tunisia, Sicily, and Italy on the 1400 miles of land lines — while work is to get underway very soon on the tripleline, 100-mile crossing of the Sicilian Strait (see special report this issue) between Cape Bon and Marzaro del Vallo.

There are also some big projects on the planning boards to excite the international pipeline business. Denmark has announced plans for a $1.2-billion gas pipeline and distribution system to be completed by 1990 that will involve some 9000 miles of pipelines, ranging from small to very big, including a 131-mile offshore pipeline. Greece has acknowledged plans for a 70-mile gas line from Italy to Corfu Island, and that could lead to other gas pipelines on the Greek mainland.

Plans for a 600-mile gas pipeline from Algeria to Spain/France across the Mediterranean — the SEGAMO project — remain alive. While Norway has abandoned plans for a 125 mile oil line from Statfjord to the Norwegian coast — tankers will be used, instead, to transport the country's oil needs — there is plenty of pipeline activity ahead in the United Kingdom where a 280-mile, 42-in. gas line gets underway next year along with a 132-mile, 16-in. NGL line.

Europe

In France, Gaz de France this year will complete 252 miles of new pipelines and has an impressive 715 miles of gas pipeline planned for 1980 thru 1982. In addition, France's section of the MEGAL (Middle European Gasoline) system — 407 miles of 30 and 36-in. — is expected to be installed in 1980. Also planned is a 350-mile, 42-in. oil line from LeHavre to the Rhine River, and 81 miles of 10-in. products pipeline from Strasbourg to Lorraine.

Seven major projects are planned in West Germany, six of them natural gas, including a 30-in. line from Emden to the Danish border for Nordgas. Deurag-Nerag plans 220 miles of 12 and 20-in.; Erdgas plans 136 miles of 20-in; Gasversorgung Suddeutschland plans 92 miles of 20-in.; Ruhrgas plans 79 miles of 20 and 24-in.; and Thyssengas plans 75 miles of 20 and 24-in. A 20-in., 90-mile oil pipeline is planned by Nordeutch Oelletitungs.

In England, as previously noted, British Gas Corp. plans a fourth gas pipeline from St. Fergus receiving terminal to Bishop Aukland. The 42-in. line will tie-in with a line built in 1978 (see special report this issue). Shell also plans to build a 132-mile, 16-in. natural gas liquids line from St. Fergus to Mossmoran above Edinburgh to transport NGL received at St. Fergus from the Flags line to a new facility at Mossmoran. Several other minor pipelines now being planned are expected to be announced in early 1980.

In Italy, in addition to nearly 700 miles of 26, 30, 36, 40, 42, 46, and 48-in. pipeline being installed as part of the Trans-Mediterranean Gas Pipeline system for SNAM, there are also plans to install 42 miles of 16-in. crude line during 1980. A major pipeline development being studied for the future is a 342-mile slurry pipeline from Montefalcone to Poland.

A 69-mile, 10-in. products pipeline in Portugal is being studied by Petrosul.

Coated and wrapped 48-in. pipe joints lie on right-of-way in shadow of Mt. Etna; they'll become part of Trans Mediterranean Gas Pipeline across Sicily, delivering Algerian gas to Italian industry and homes.

In Spain, a 530-mile gas pipeline system from Barcelona to Bilbao for Enagas is being designed for 1980 construction start.

Pipelines are not a common transportation means in Greece, so it is news that Greece has studies underway to build a 60-mile undersea pipeline from Otranto, Italy, to Corfu Island, going subsea across the Strait of Otranto. Another 10 miles of land line would be required. Greece also is studying plans to build a 150-mile oil line from Korinos to Skopje, Yugoslavia.

The MEGAL system will also include 388 miles of 32 to 40-in. line in West Germany, from the Austrian border to the French border to supply gas from the U.S.S.R. to customer companies in West Germany and in France. The continuing French section, noted previously, would involve 86 miles of 36-in. from Medelsheim to Voisines, 86 miles of 30-in. from Voisines to Ervy, and 83 miles of 30-in. from Voisines to Allerex.

Norway, even though it has abandoned its 125-mile oil line from Statfjord to Sotra and the 110-mile gas line to Karmoy, is keeping alive plans to build a 600-mile large diameter pipeline to take gas from Statfjord to the European continent.

Sweden, with plans to import Algerian LNG by 1985, is also looking for gas from Denmark via an 11-mile, 24-in. gas line across Oresund Sound. Another 186 miles of 24 and 36-in. gas line from Malmo to Halstead is also planned by Swedegas.

Denmark's big $1-billion gas project to be built by the state-owned Danish Oil and Natural Gas Co., will involve a 131-mile, 36-in. offshore gas line from Cora Field to onshore (cost estimated at $210 million) plus 562 miles of 16 to 30-in. transmission lines (mostly 20-in.) and 8688 miles of 2 through 16-in. distribution lines.

Africa

Bulk of the pipeline activity in Africa is in North Africa, and, more specifically, in Algeria, where four major gas lines and a large diameter NGL line are being installed with 1980 completion dates set. Sedco is building a 317-mile, 42-in. line from Hassi R'Mel to Arzew, while NACAP B.V. is installing a 318-mile, 40-in. line along the same route, plus 124 miles of 40-in. northwest out of Hassi R'Mel to tie in with a previously built line. Bechtel is building the 350-mile, 24-in. NGL line. Another 300 miles of 10 to 40-in. line are being planned in the Hassi R'Mel area. Saipem is building the 341 miles of 48-in. from Hassi R'Mel to the Tunisian border — the line that originates the vast 1700-mile Trans Mediterranean Gas Pipeline System.

In Libya, a 130-mile, 16-in. products line from Zawia to

INTERNATIONAL PIPELINE CONSTRUCTION — BY AREAS

(Underway, Planned, and Proposed – September 1979) In Miles

	Miles of Gas Pipelines		Miles of Crude Oil Pipelines		Miles of Product Pipelines		Miles of Slurry Pipelines		Total Miles	
	*Total	Underway	Total	Underway	Total	Underway	Total	Underway	Total	Underway
Europe	14488	1960	1653	747	1111	679	342	—	17594	3386
Africa	4313	1189	2825	2002	1972	709	—	—	9110	3900
Middle East	5046	108	6608	1892	5306	4355	—	—	16960	6335
Asia, Japan & Pacific	2240	100	2159	2144	1059	525	171	—	5629	2769
Australia & N.Z.	2354	81	24	—	2375	39	168	—	4921	120
Canada	10226	1129	2459	91	1282	82	—	—	13967	1302
Central America & Mexico	1285	666	873	554	1991	831	—	—	4149	2051
South America	6007	40	2804	966	1189	44	55	—	10055	1050
SUBTOTAL	**45959**	**5273**	**19405**	**8396**	**16285**	**7244**	**736**	—	**82385**	**20373**
USSR	6105	4105	2630	580	2006	1500	1490	—	12231	6185
E. Bloc	2036	1505	879	767	276	88	—	—	3191	2360
China	1200	—	2120	—	—	—	—	—	3320	—
SUBTOTAL	**9341**	**5610**	**5099**	**1347**	**2282**	**1588**	**1490**	—	**18212**	**8545**
TOTAL	**55300**	**10883**	**24504**	**9743**	**18567**	**8832**	**2226**	—	**100597**	**28918**
(Iran)	−3441	−1247	− 363	− 363	−2063	−1996	—	—	−5867	−3606
Grand Total	**51859**	**9636**	**24141**	**9380**	**16504**	**6836**	**2226**	—	**94730**	**25852**

**Total indicates all planned lines plus lines under construction at survey time.*

Zuara is being completed by Montubi, while a 114-mile, 16 and 20-in. gas line from Zella-Aswad to Sabah continues to be planned by Occidental. For Libyan National Oil Co., Entrepose is completing a 280-mile, 18-in. oil line from Hamadat al Hamra to near Tripoli at a cost of $16 million.

Tunisia's major pipeline venture is the 224-mile, 48-in. section of the Trans Mediterranean Gas Pipeline. Another 80-mile gas line from the offshore Miskar field to Sfax is planned.

Zaire has under study a 200-mile products pipeline from Kinshasa to the interior while the Tanzania to Sambia 1060 mile products pipeline is also being studied.

Middle East

Big news in Saudi Arabia is that work is progressing on the big 787-mile, 48-in. Petroline oil pipeline from Abqaiq to Yanbu (see special report this issue) as well as on the parallel 746-mile, 28 and 30-in. natural gas liquids line for Aramco Services.

Other major work in Saudi that is underway or planned includes 408 miles of 32 and 34-in. oil line from Shaybah to Ju'aymah; 160 miles of 36 and 40-in. gas line from Uthmaniyah to Jubail; 255 miles of 24 to 42-in. gas line from Uthmaniyah to Berri; 211 miles of 28 to 40-in. NGL line from Uthmaniyah to Ju'aymah; 82 miles of 12 to 48 sour gas gathering lines and 66 miles of 3 to 12-in. NGL gathering lines near Shedgum; and 130 miles of 16 to 38-in. sour gas gathering line and 80 miles of 2 to 6-in. NGL gathering line near Uthmaniyah.

Abu Dhabi has 221 miles planned from Bultasa field to Ruwais and the 746-mile, 4 to 48-in. ZADCO system that will gather offshore and onshore oil and gas — to be built at a cost of $500 million.

Oman recently let contract for a 279-mile oil pipeline from Amal and Marmul fields to Qarn Alam to Dodsal GmbH; line is to be completed by April 1980. Other Oman projects planned include a 137-mile oil line from Amal/Marmul to Salah, a 310-mile, 20-in. line "somewhere" in Oman, a 140-mile 16 and 20-in. offshore gas line, and 201 miles of gas gathering system.

In Iraq, projects planned include a 435-mile oil and gas gathering system near Kirkuk and other northern fields; a 292-mile, 20 and 22-in. oil line from Kirkuk field to near Baghdad; a 185-mile, 8-in. LPG line from Kirkuk to Baghdad; a 775-mile, 48-in. oil line from southern Iraq to Tartus on the Mediterranean, and a 750-mile 42-in. gas line from North Rumaila to Tartus.

In Kuwait, a 400-mile gas gathering system is planned for 1980 construction.

In Turkey, a 274-mile, 24 and 26-in. oil line from Yumurtallk to Kirikkale is planned.

Iran: Question Mark

Will pipeline construction activity eventually be resumed in Iran?

It's a burning — and leading — question that is dodged publicly by those firms that were building pipelines in Iran before the political upheaval in late 1978.

It is also no secret that no pipeline work has been done since that time and that most "foreign" pipeline experts and skilled workers are now gone from Iran. Status of the many projects is indefinite. So is status of the millions of dollars of equipment owned by "foreign" contractors. It hasn't been officially expropriated, but it also has not been returned.

Iran's new government decided to halt construction of the IGAT II gas pipeline, which would have permitted gas exports from Iran to Russia, which in turn would have permitted gas exports from Russia to Europe. The 883-mile, 56-in. line was to be completed in 1981. It would have transported 600 billion cu ft per year to the U.S.S.R., who would export an equivalent amount of gas from central Russia to France, West Germany, Austria, and Czechoslovakia.

Many other oil and gas pipeline projects in Iran — 5867 miles total, including 3606 actually underway and 2684 planned — were also halted. There were also many projects that had been "completed" but not really placed in service. The total disruption is difficult to visualize, but it has occurred.

Middle East observers see no improvement in the Iranian political situation in the near future, and even greater economic woes to come. Unfortunately, many skilled Iranians — especially those knowledgeable about oil fields and gas fields and pipelines — are fleeing that country.

Welders lay in hot passes on the 48-in. pipe used on Trans Mediterranean Gas Pipeline.

International pipeline contractors have privately resolved that Iran holds no immediate future for them, and those who were working there, or held future contracts, are now seeking opportunities elsewhere.

Southeast Asia

Okinawa's newest offshore pipeline has been completed (see special report this issue).

In Thailand, the long-planned offshore/onshore gas pipeline system has not yet reached the construction stage, but is expected to get underway in late 1979 or early 1980. Involved are 275 miles of 34-in. offshore gas pipeline and 100 miles of 28-in. onshore gas line, to be built for the Natural Gas Organization of Thailand. A 234-mile, 10/12/14-in. products pipeline is also being studied in Thailand.

Malaysia plans a 36-in. gas pipeline from Luconia field to Shell's Sarawak LNG plant.

In India, Dodsal Private Ltd. is currently installing a 500-mile, 24-in. oil line from Viramgam to Mathura. A 300-mile products line from Mathura to Jullundur is also underway.

Pakistan's pipeline activity includes 500 miles of 16 and 20-in. from Karachi to Multan, to be completed in 1980. Planned by Sui Northern Gas are 478 miles of 12-in. gas gathering system and 185 miles of 1 to 6-in. gas gathering lines.

In China, some 1200 miles of gas pipelines are being studied, along with 2120 miles of crude oil pipelines, but no target dates have been announced (see special report this issue on China's gas industry).

Australia And New Zealand

Australia has a host of pipeline projects on paper — ranging from small extensions of existing lines to giant transcontinental proposals. Most likely to begin construction in 1980, if all the political obstacles can be overcome, is the 863-mile, 26-in. gas pipeline from Dampier to Perth, which will transport gas from the North West Shelf. Near Sydney, a 102-mile, 14 and 20-in. gas pipeline is getting underway for Australian Gas Light Co.

In New Zealand, completion of the Maui gas project is expected to lead to new pipeline construction as the gaseous fuel is introduced to other areas there.

Mexico And Central America

Mexico, whose expanding economy requires commensurate expansion of its oil and gas industry to provide needed energy, has embarked on a substantial pipeline expansion program. Planned and underway pipelines involved include 969 miles of gas pipeline, 554 miles of crude oil pipelines, 1760 miles of products pipelines — for a total of 2979 miles. (See special report this issue for details).

Major pipeline project in Guatemala is a 143-mile, 10 and 12-in. oil line being built by Entrepose. A planned 227-mile, 48-in. crude oil line, designed principally to handle Alaskan oil, remains on the boards.

In Panama, a 36-mile, 12-in. crude oil line across the Isthmus is planned.

South America

In Argentina, Gas del Estado's 1087 mile Central West Gas Pipeline System may get underway by the end of 1979. The $450 million project involves 700 miles of 30-in., 138 miles of 18-in., 105 miles of 12-in., and 144 miles of 8-in. The massive program will also embrace a gathering system in the Neuquin Basin.

The $1-billion, 1248-mile, 24 and 30-in. dual gas pipeline system that will be two-thirds in Brazil and one third in Bolivia continues to be planned by Petrobras and YPFB.

Bolivia's YPFB also has plans for a 405-mile gas system in that country.

Brazil's Petrobras recently awarded a $14-million contract to Williams Brothers Engineering Co. to design a 312-mile, 8 to 24-in. offshore gathering system for the Campos Basin fields some 188 miles east of Rio de Janeiro.

In Colombia, a 621-mile, 20-in. gas pipeline is being planned from Jobo-Tablon to Medellon and Cali.

Chile has a 112-mile, 30-in. gas pipeline planned to bring gas to the proposed LNG liquefaction and shipping terminal at Cabo Negro. Chile is also the site of a 40-mile, 40-in. and 10-mile, 30-in. slurry line for copper concentrate from Sewell to Callogne.

Russia, Eastern Bloc

Recent reports in the U.S. press noted that the Soviet Union will spend nearly $5.4 billion on pipelines in 1979; that includes completion of the Soyuz gas pipeline (1700 miles) with the installation of its compressor stations, and completion of the 1500-mile ammonia pipeline from Togliatti to Odessa that has been underway the past four years. Planned — and possibly underway by now — is a 2050-mile oil pipeline from Surgut to Polotsk, and a new 56-in. gas line loop from Urengoi to Chelyabinsk.

Yugoslavia's 903-mile 16 and 20-in. gas system is nearly one-half complete. 398 miles will be completed in 1979, the other 595 miles in 1980.

A 65-mile 24-in. crude line from the Adriatic through Yugoslavia to the Hungarian border is planned; local lines would be built to extend the line inside Hungary.

Czechoslovakia expects to complete during 1980 its 539 miles of 40/48/56-in. gas line that ties in with the Soyuz pipeline from the U.S.S.R.

Canada

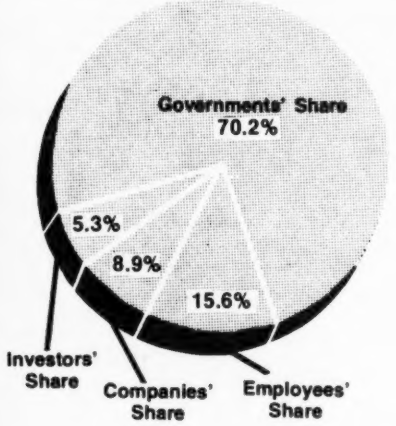
The bureaucratic tangle that has delayed for several years Canadian plans to build major gas pipelines continues to strangle activity in this nation in the upper part of North America. Canada's planning boards hold some big projects: 2032 miles of 36/42/48/56-in. for the Canadian section of the Alaska Highway Gas Pipeline Project, to be built by Foothills Pipe Lines (Yukon) Ltd.; the 2338-mile, 36 and 42-in. Polar Gas Project; the 1124-mile, 36-in. Foothills Oil Pipeline; the 710-mile Transmountain Oil Pipeline project; the 1245-mile 24-in. Q&M Pipeline project to extend gas service to the Maritimes (and the competing TransCanada PipeLine proposal to extend service to the same area).

All of the projects related to moving Alaskan oil or Alaskan gas to the U.S. through Canada require some form of approval by U.S. regulatory agencies, and that has been a firm delaying factor.

P&GJ

Beneficiaries of Integrated Oil Companies' Operations

Employees' pay and benefits after taxes	$14.319 billion	EMPLOYEES' SHARE	15.6%
Earnings of 48 companies after dividends	$ 8.192 billion	COMPANIES' SHARE	8.9%
Dividends after taxes paid by stockholders	$ 4.823 billion	INVESTORS' SHARE	5.3%
Taxes paid by companies/investors/employees and collected from consumers	$64.331 billion	GOVERNMENTS' SHARE	70.2%
BOTTOM LINE	$91.665 billion		100.0%



Governments Take Major Share

by Ernestine Adams, *Editor, Energy Management Report*
and Julie Fonner, *Assistant Editor*

The fourth year for this table shows governments – USA and foreign, local and national – take more than 70% of the funds paid to 48 oil companies in their operations.

This estimate of governments' share is very conservative. Every time an oil company buys equipment, services and supplies it adds to governments' revenues.

All firms selling to petroleum companies pay taxes at every government level; their stockholders pay sales, income, property, school and any other taxes levied by various government levels in the USA and other countries.

Although purchases of services, equipment and supplies are usually the largest portion of oil company expenses, these are not included in this particular table.

Compared with last year only the employees' percentage share of funds generated by oil companies has increased. Companies' earnings, investors' dividends and governments' share are all virtually the same.

All figures are higher but not enough to balance inflation.

INCOME SHARES GENERATED BY 48 OIL COMPANIES' OPERATIONS IN 1978

	COMPANY'S SHARE	INVESTORS' SHARE	EMPLOYEES' SHARE	GOVERNMENTS' SHARE				
Company	Net income* after dividends ($000)	Dividends ($000)	Payrolls & Benefits ($000)	Taxes on dividends[1] ($000)	Taxes on employees' share[2] ($000)	Excise taxes on products[3] ($000)	Other taxes[4] ($000)	Total taxes ($000)
Adobe Oil & Gas	6,006	1,538	1,802	308	601	0	208	1,117
Amerada Hess	96,249	46,169	82,000[e]	9,234	27,333	56,000[e]	384,089	476,656
American Petrofina	8,845	23,506	74,531	4,701	24,844	59,917	15,037	104,499
Ashland Oil	176,117	68,657	526,854	13,731	175,618	259,516	213,334	662,199
Atlantic Richfield	515,810	288,515	1,016,500	57,703	338,833	440,406	631,775	1,468,717
Cities Service	32,266	85,767	440,843	17,153	146,948	170,216	182,353	516,670
Clark Oil & Refining	11,758	4,267	91,800	853	30,600	139,004	31,128	201,585
Coastal States Gas	49,830	10,593	137,620	2,119	45,827	46,300	49,000	143,246
Conoco Inc.	284,304	153,037	895,800	30,607	298,600	232,259	1,752,266	2,313,732
Crown Central Petr.	16,902	1,719	36,501	344	12,167	79,612	23,261	115,384
Crystal Oil	(1,566)	1,729	7,991	346	2,664	1,606	660	5,276
Diamond Shamrock	74,036	57,027	199,112[e]	11,405	66,371	250,000[e]	87,495	415,271
Dorchester Gas	15,031	0	7,677	0	2,559	269	5,920	8,748
Earth Resources	5,822	5,206	20,171	1,041	6,724	9,473	7,392	24,630
Exxon	1,290,760	1,472,240	3,450,000	294,448	1,135,000	3,560,532	13,955,749	18,945,729
Getty	239,437	88,314	306,390	17,663	102,130	161,993	645,926	927,712
Gulf Oil	420,000	371,000	1,345,000	74,200	448,333	1,823,000	1,666,000	4,011,533
Holly Corp.	7,151	0	8,000[E]	0	2,667	6,000[E]	6,000[E]	14,667
Husky Oil Ltd.	44,027	11,433	74,713	2,287	24,904	53,000[e]	35,936	116,127
Kerr-McGee Corp.	85,876	32,320	224,000	6,464	74,667	104,400	130,634	316,165
Louisiana Land & Expl.	54,017	46,335	60,153	9,267	20,051	0	112,842	142,160
Mapco Inc.	20,784	23,509	79,000	4,702	26,333	2,783	40,005	73,823
Marathon Oil	130,611	66,456	295,568	13,291	98,523	395,298	629,098	1,136,210
Mobil Corp.	670,015	455,623	2,325,852[e]	91,125	775,284	1,948,048	6,548,439	9,362,896
Murphy Oil	36,657	9,932	82,673	1,986	27,558	186,330	113,683	329,557
Marion Corp.	7,133	732	6,190[e]	146	2,063	5,745[e]	3,802	11,756
Occidental Petr.	(112,765)	119,465	697,240	23,893	232,413	3,432	834,372	1,094,110
Pacific Resources	1,384	7,884	14,150	1,577	4,717	0	7,138	13,432
Pennzoil Co.	57,755	70,412	185,660	14,082	61,887	28,327	109,966	214,262
Phillips Petroleum	525,694	184,785	720,489	36,957	240,163	176,000	1,117,363	1,570,483
Quaker State	9,921	15,424	88,045	3,085	29,348	9,489	20,225	62,147
Reserve Oil & Gas	10,134	6,666	35,000	1,333	11,667	32,719	10,831	56,550
Shell Oil	545,990	267,633	1,051,000	53,527	350,333	886,680	779,568	2,070,108
Southern Union Co.	8,622	13,425	39,000	2,685	13,000	1,305	19,244	36,234
Standard California	671,300	434,581	994,000	86,916	331,333	873,184	1,864,071	3,155,504
Standard Indiana	666,451	409,961	1,126,731	81,992	375,577	1,177,700	1,876,500	3,511,769
Standard Ohio	359,611	90,594	431,998	18,119	143,999	287,678	378,461	828,257
Sun Co.	211,477	140,864	769,580	28,173	256,527	486,135	591,264	1,362,099
Tenneco Inc.	207,000	227,900	1,200,000[e]	45,580	400,000	200,000[e]	186,000	831,580
Tesoro Petroleum	21,628	9,535	54,737	1,907	18,246	16,800	18,441	55,394
Texaco Inc.	309,553	542,908	1,572,800	108,582	524,267	2,631,320	2,781,600	6,045,769
Tipperary Corp.	(1,753)	0	2,413	0	804	0	1,133	1,937
Texas American Oil	3,336	5% stock	1,800[e]	0	600	0	1,448	2,048
Texas Eastern Corp.	82,277	54,929	108,673	10,986	36,224	0	149,575	196,785
Tosco Corp.	15,422	0	71,506	0	23,835	133,032	9,893	166,760
Total Petroleum (N.A.)	14,510	2,306	28,101	461	9,367	18,185	10,000	38,013
Union California	279,499	102,783	444,900	20,557	148,300	384,700	519,100	1,072,657
United Refining	6,684	1,147	22,000	229	7,333	66,267	25,080	98,909
TOTAL	8,191,608	6,028,826	21,456,564	1,205,765	7,137,142	17,404,660	38,583,305	64,330,872

[1] Taxes on dividends are 1/5, up from 1/6 used in 1976 and 1975 because inflation increases tax without a rate increase.
[2] Employees' taxes are estimated at 1/3, calculated by Taxpayers' Foundation as the average rate for employeed persons.
[3] U.S. federal excise tax 4¢/gal. in 1978; state taxes averaged about 8¢/gal. Other products have lower excise tax. [4] Taxes levied directly on companies: income taxes (before dividends), property taxes, severance taxes on oil/gas production, sales tax on goods purchased, tariffs. *Excluding non-recurring items. [E] Estimate. [e] Our estimate.

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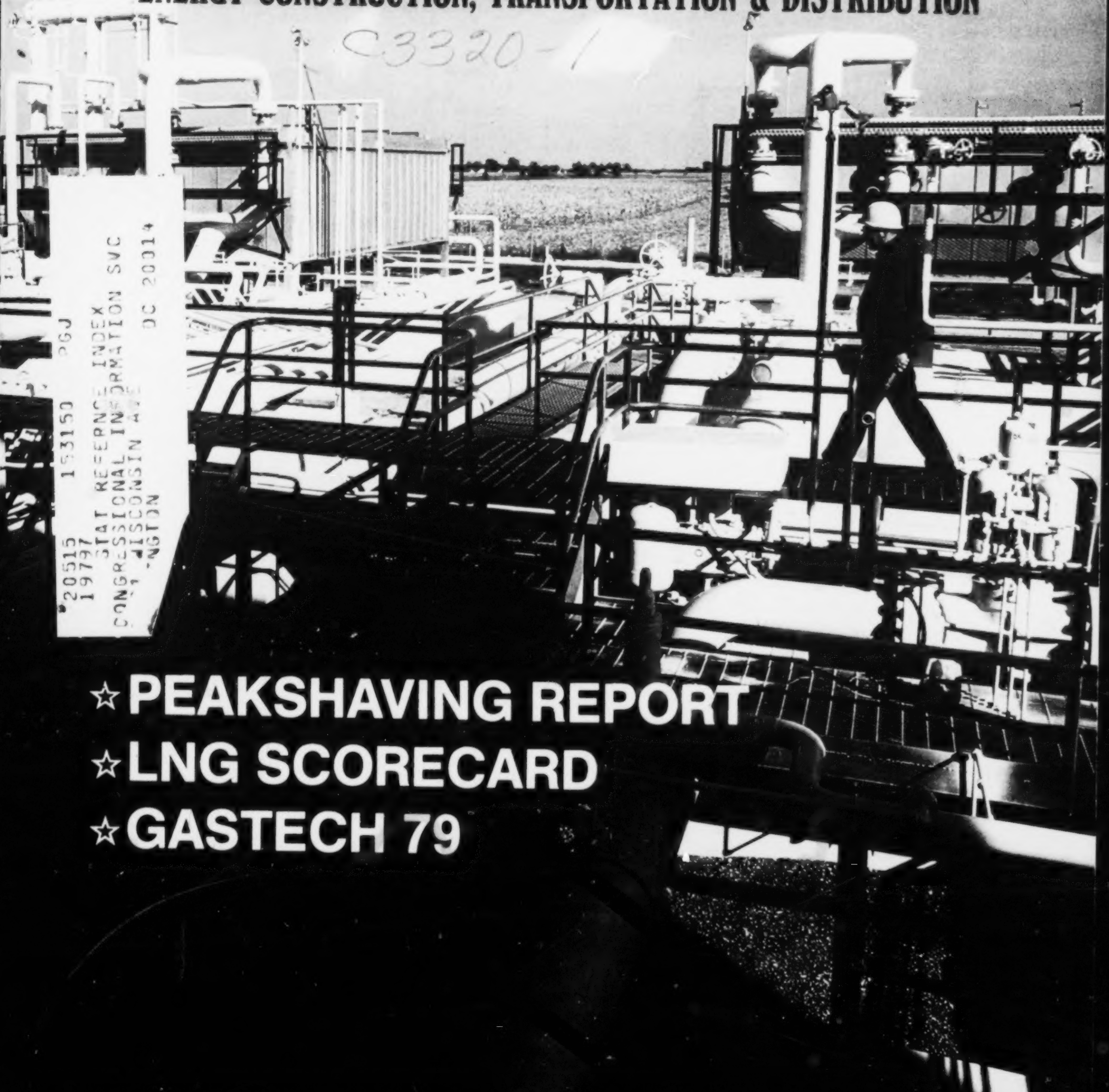

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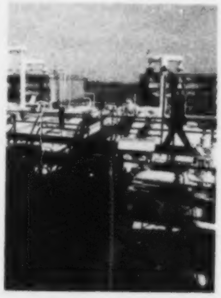


Underground storage of natural gas requires miles of piping at the surface—and miles of pipelines to transport it to the gas distribution systems' mains and services that deliver the efficient fuel to heat homes and industries at peak demand times of winter.

—Photo courtesy Northern Indiana Public Service Co.

Peakshaving Report 22

U.S. peakshaving capabilities will be at a record high for the 1979-1980 winter season as underground gas storage capacity and withdrawal/sendout capacity reach new peaks and LNG peakshaving capacity reaches an all-time high; new peakshaving capacity is 69.86 billion cu ft per day.

Underground Gas Storage Data 24

Complete listing of companies who operate underground gas storage reservoirs including information on facilities in use.

LNG Scorecard 26

Latest tabulation on U.S., Canadian, and International peakshaving facilities, including both large and small satellite plants.

Consumers' Gas LNG Satellite Firms Ottawa Valley Gas Supply 30

New LNG peakshaving satellite plant, supplied from Montreal LNG peakshaving/liquefaction plant, is ideally located in middle of service area and has proven itself in both emergencies and for peakshaving service.

Northwest Natural Newport LNG Plant First To Use CRYEX Purification 40

New concept for removing carbon dioxide from gas stream is incorporated into Northwest Natural Gas Co.'s LNG peakshaving facility on Yaquina Bay 114 miles southwest of Portland, Oregon.

Colonial's 1979 Expansion A Struggle With Weather 50

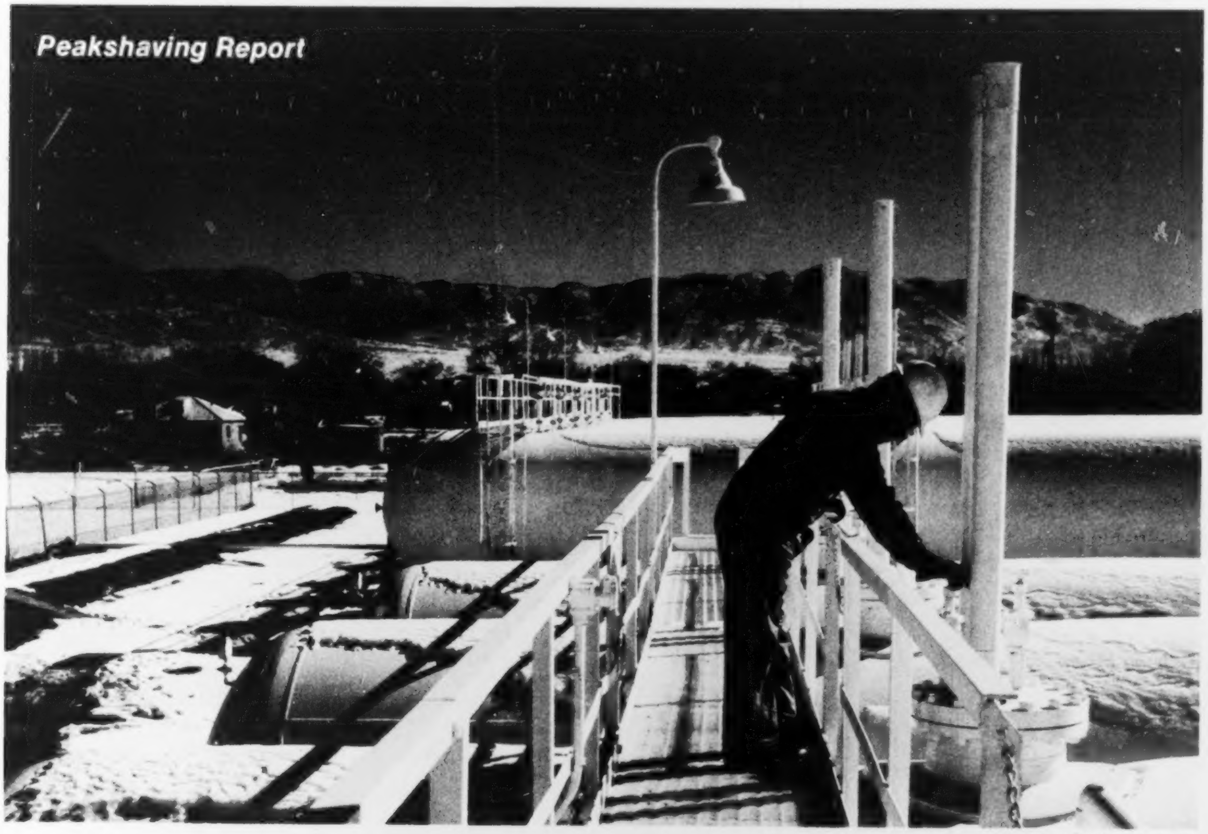
Latest season in Colonial Pipeline Co.'s continuing expansion program involved 278 miles of pipeline and 116,900 hp installed at a total cost of over $214 million.

Gastech 79 Conference/Exhibition To Host Over 1000 In Houston 60

International energy authorities and representatives from the worldwide energy supply, transportation, and distribution business to meet in Houston on November 13-16.

Windmill Powers Cathodic Protection System 70

It is almost perpetual power... the windmill-mounted power generator used by Texas Eastern Gas Pipeline Co. to power its cathodic protection system on a remote stretch of 30-in. gas pipeline in deep south Texas.



—courtesy Southern Union Co

Plant operator checks valves at storage area of the propane-air facility of Gas Company of New Mexico at Albuquerque. Plant is one of nearly 500 utilized by gas industry to meet peak winter demands.

Peakshaving Capabilities Ready For '79-'80 Winter Season

by Dean Hale, *Editor*

There will be plenty of peakshaving capacity available during the 1979-1980 winter heating season to enable the gas industry to meet needs of its customers. That capacity – 69.86 billion cu ft over a 24-hr period – comes on top of an increase in regularly scheduled deliveries – to an estimated 64.5 Bcf/day – by gas pipeline suppliers. Projected maximum delivery in one day, should it happen that all valves be opened, could reach as high as 134 billion cu ft in one 24-hr period, according to data gathered in PIPELINE & GAS JOURNAL's annual peakshaving survey.

Such an occurrence isn't likely, however. The entire nation is not likely to experience a major cold wave on a single day. And it is possible that field production curtailments could reduce pipeline flows up to 10%. Still, the amount available is about 69% greater than the 79+ Bcf reported as the peak-day total gas sendout during the 1978-1979 winter heating season.

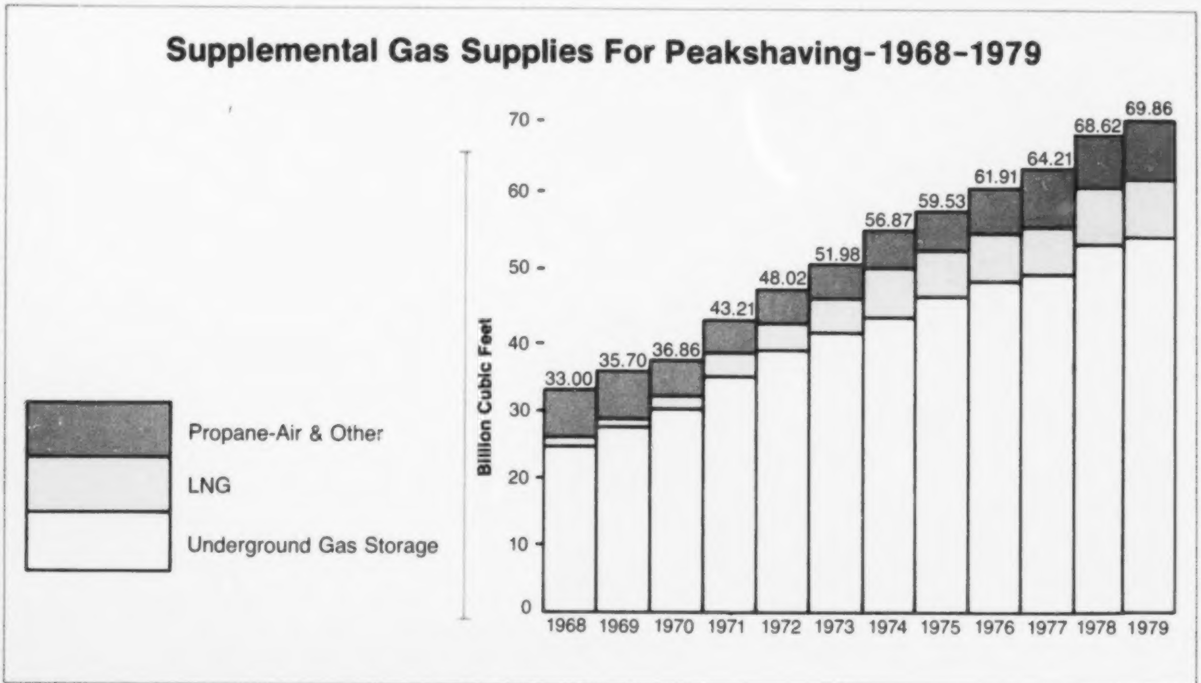
For the 1979-1980 winter, a peak-day gas sendout total of 80 to 84 Bcf in 24 hr is considered most probably unless Mother Nature delivers an extended deep-freeze over a large area of the country.

Supplemental gas supplies will be providing for a good chunk of gas demand at any one time in *some* area of the country–perhaps 50% to 70% in some instances–but industry authorities told PIPELINE & GAS JOURNAL that there is little possibility of an extraordinary high delivery day beyond the 84 Bcf point.

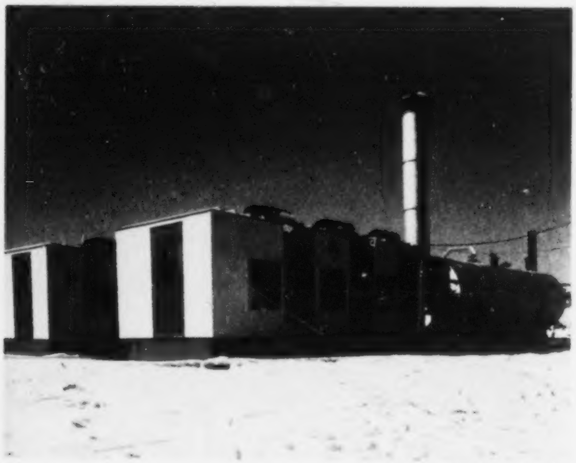
For the 1979-1980 winter season, peakshaving supplies will include:

55.39 Bcf from underground gas storage
5.11 Bcf from propane-air plants
8.98 Bcf from LNG peakshaving and satellite plants
0.38 Bcf from other sources

Major increase during 1979 over 1978 figures is in deliverability from underground gas storage facilities–approximately a 2% increase and 1.01 Bcf. Deliverability by LNG peakshaving plants and satellite facilities gained 2.4%, while propane-air plants' increased by slightly less than 1%. "Other" sources include sendout from SNG plants operated for peakshaving purposes (mothballing of SNG facilities has increased notably in recent months as government regulations prevent them from operating



Supplemental Gas Supplies For Peakshaving-1968-1979



—courtesy Applied Engineering Co

Framingham, Mass., propane-air plant of Worcester Gas Light Co. provides sendout of 20 million cu ft per day at 100 psig.

economically, along with line pack, buried bottle-type storage, gas holders, and enrichment of gas stream by direct injection of propane or ethane or boost Btu content.

Underground Gas Storage Activity

The search for new underground gas storage fields and continuing expansion and modernization of existing storage facilities continued its march during 1979.

As of November 1, 1979, there were 406 gas storage fields belonging to 89 companies, of which 377 are classified as active, 19 are considered as being under development, seven are planned, and three are "being depleted" and will no longer be used. Total capacity of the fields (working gas plus cushion gas) exceeds 7.254 trillion cu ft while working capacity is estimated at 3.561 trillion cu ft. Maximum deliverability is estimated at 55.391 billion cu ft in a 24-hr period, according to PIPELINE & GAS JOURNAL's peakshaving survey data.

Expenditures of $243,169,000 for new underground storage facilities (drilling and completing wells, installing field lines, and installing compressor horsepower and other related measurement, filtering, and dehydrating equipment and controls) were reported. Expenditures for 1980 for underground gas storage facilities by gas utilities and gas transmission pipeline companies are expected to exceed $285,000,000, according to the survey.

At the 396 operating and under-development gas storage fields, current statistics indicate there are 17,652 wells (a net increase of 234 over 1978), 6818 miles of field lines (up a net 136 miles over 1978), and a net gain of three compressor stations with a net increase of 41,900 hp for the year.

Outlook for 1980 underground gas storage developments:

ANR Storage Co. plans include development of four fields in Michigan–Rapid River 35, Cold Springs 12, Cold Springs 31, and Excelsior 6. The first two are part of a nearly $66-million program to provide storage for five major gas companies. The latter two will be developed as part of a $26.6-million program recently announced.

National Fuel Gas Storage Corp. plans to spend $64,753,575 to expand three fields–East Independence, West Independence, and Beech Hill (all in New York)–to provide 23.5 Bcf storage capacity in which 11 other gas companies would be able to reserve up to 16.05 Bcf storage for their accounts. Program would take three years to complete.

Washington Natural Gas Co., as operator for a three-company joint venture at Jackson Prairie gas storage in Washington State, plans to continue development of the field's Zone 9. In an application field at end of August to FERC, WNG indicated that deliveries to Northwest Pipeline Corp. from the field would be increased to 325,000 Mcf per day plus an additional 71,800 Mcf per day on a best-efforts basis.

Panhandle Eastern Pipe Line Co. plans to increase storage capacity of the Tuscola field in Illinois (Mt. Simon formation) to 9 Bcf and plans to add a 1000-hp compressor that will go into service in early 1980. PEPL also is continuing development of the Montezuma field in Indiana.

Southwest Gas Storage Co., a joint venture of Panhandle Eastern and ANR Storage Co., has asked FERC for author-

U.S. Underground Gas Storage Operations — Operating Companies — 1979 Data

Company		No. of Fields	No. of Wells	Miles Storage Lines	Storage Compressor Stations	
					No.	HP
ANR Storage Co.		4	(under development)		3	27,000
Arkansas Louisiana Gas Co.		4	52	22.00	4	35,415
Arkansas Oklahoma Gas Corp.		1	12	3.00	1	370
Arkansas Western Gas Co.		4	11	3.72	4	1,175
Battle Creek Gas Co.		2	2	N/A	1	600
				– (1 under development) –		
Bear Creek Storage Co.		1		– (under development) –		
Brady, Tex., Municipal Gas Corp.		1	2	2.00	1	420
Cabot Corp.		2	14	14.60	2	2,395
Central Illinois Light Co.		2	86	21.27	2	4,265
Central Illinois Public Service		3	78	9.80	3	3,220
Cities Service Gas Co.		10	589	164.00	6	29,800
Citizens Gas & Coke Utility		8	182	319.00	2	3,695
Colorado Interstate Gas Co.		4	122	230.00	3	9,700
Columbia Gas Transmission Corp.		51	3,626	1,175.40	28	105,335
Columbia Gas of Pennsylvania		1	8	3.43	1	900
Consolidated Gas Supply	owned	9	1,040	458.00	9	119,300
	joint	4	296	117.00	8	60,390
		13	1,336	575.00	17	179,690
Consumers Power Co.		11	477	128.66	4	78,810
Delhi Gas Pipeline Corp.		1		– (under development) –		
East Ohio Gas Co.		4	756	253.02	3	20,220
El Paso Natural Gas Co.		2	35	39.00	1	4,400
				– (1 planned) –		
Equitable Gas Co.		15	280	148.10	9	15,580
Felmont Oil Corp.		1	10	6.00	1	1,050
Gas Utilities (Ill.)		1	6	3.10	–	–
Hampshire Gas Co.		1	13	17.00	1	1,640
Honeoye Storage Corp.		1	34	15.80	1	2,200
Hoosier Gas Corp.		3	24	8.30	0	–
Houston Pipe Line Co.		1	42	10.00	1	12,660
Illinois Power Co.		8	237	34.75	8	12,100
Indiana Gas Co.		7	272	106.06	2	2,602
Kane Gas Light & Heat Co.		1	21	10.00	1	60
Kansas Nebraska Natural Gas		4	32	23.40	3	5,530
Laclede Gas Co.		1	50	31.58	1	9,020
Lawrenceburg Gas Co.		1	1	–	–	–
Lone Star Gas Co.		12	112	78.58	11	25,275
Louisville Gas & Electric Co.		9	834	126.16	3	18,900
LoVaca Gathering Co.		2	–	–	–	–
Michigan Consolidated Gas Co.		5	483	90.00	4	71,000
Michigan Gas Storage		3	554	166.10	1	30,900
Michigan Gas Utilities Co.		1	4	3.00	1	800
Michigan Wisconsin Pipe Line Co.		14	1,140	295.00	7	88,500
				– (1 under development) –	1	6,000
Midwestern Gas Transmission Co.		3	55	11.70	2	1,593
Minnesota Gas Co.		1	40	15.00	1	2,200
Mississippi River Transmission Corp.		3	66	72.06	3	22,050
Mississippi Valley Gas Co.		1	3	1.00	1	584
Montana-Dakota Utilities Co.		3	87	103.00	3	20,222
Montana Power Co.		4	37	38.00	3	5,670
Mountain Fuel Resources Inc.		1	19	15.5	1	28,400
Mountain Fuel Supply Co.		3	26	10.0	3	5,500
Mustang Fuel Corp.		1	1	4.00	–	–
Natural Fuel Gas Supply Corp.	owned	30	951	486.80	14	237
	joint	4	329	63.10	(4)	(39,900)
	Total	34	1,280	549.90	14	237
				– (3 under development) –		
National Gas & Oil Corp.		3	31	8.00	3	1,950
National Zinc Co.		1	7	–	1	119
Natural Gas Pipeline Co. of America		13	850	305.00	8	119,040
North Penn Gas Co.	owned	2	18	12.70	1	4,995
	(joint	1)				
Northern Gas Co.		4	8	13.00	4	1,900
Northern Illinois Gas Co.		7	505	264.03	6	113,990
Northern Indiana Public Service		3	135	29.00	2	7,320
Northern Natural Gas Co.		3	293	128.50	2	15,960
Oklahoma Natural Gas Co.		4	62	22.00	2	11,500
Pacific Gas & Electric Co.		3	95	22.47	3	10,990
Panhandle Eastern Pipe Line Co.		4	203	109.00	4	19,450
Peoples Gas Light & Coke Co., The		1	137	189.00	1	14,900
Peoples Natural Gas Co.		8	80	34.00	5	10,720
Peoples Natural Gas Div., Western Region, Northern Natural Gas		1	1	2.00	1	75
T. W. Phillips Gas & Oil Co.		7	74	–	7	1,995
Phillips Petroleum Co.		3	6	22.00	2	620
Pioneer Natural Gas Co.		2	1	1.00	1	880
				– (1 under development) –		
Public Service Co. of Colorado		1	13	8.27	1	17,000
Saxonburg Heat & Light Co.		3	6	3.00	2	50
South Louisiana Production Co.		1	3	10.00	1	30
		2	6	2.00	1	2,600
Southeastern Michigan Gas Co.						
Southern Indiana Gas & Electric Co.		2	83	17.30	2	1,500
Southern Natural Gas Co.		1	73	48.22	1	21,750
Southern California Gas Co.		7	311	89.70	6	104,090
				– (1 under development) –		
Southern Union Co. (Gas Co. of New Mex.)		1	11	12.00	1	3,000
Southwest Gas Storage Co.		1		– (planned) –		
Southwestern Gas Pipeline, Inc.		2	11	3.45	1	440
Tennessee Gas Pipeline Co.	(joint	4)	345	2.00	2	19,600
Texas Eastern Transmission Corp.	owned	1	69	27.20	1	11,000
Texas Gas Transmission Corp.		10	447	244.60	11	17,515
Transcontinental Gas Pipe Line Corp.	owned	3	56	22.45	3	46,100
	(joint	2	181	79.00	2	34,300)
Trunkline Gas Co.		1		– (under development) –		
Union Gas System, Inc.		5	115	25.00	2	660
Union Light, Heat & Power Co.		1	25	28.00	–	–
United Gas Pipe Line Co.	owned	1	19	6.10	1	2,550
	joint	1	73	21.70	1	34,000
	Total	2	92	27.80	2	36,550
Victor Gas Co.		1	6	12.00	2	300
Washington Natural Gas Washington Water Power Co. Northwest Pipeline Corp.	joint	1	77	9.10	1	12,500
Western Kentucky Gas Co.		6	58	19.30	4	1,555
Western Slope Gas Co.		2	9	8.80	1	650

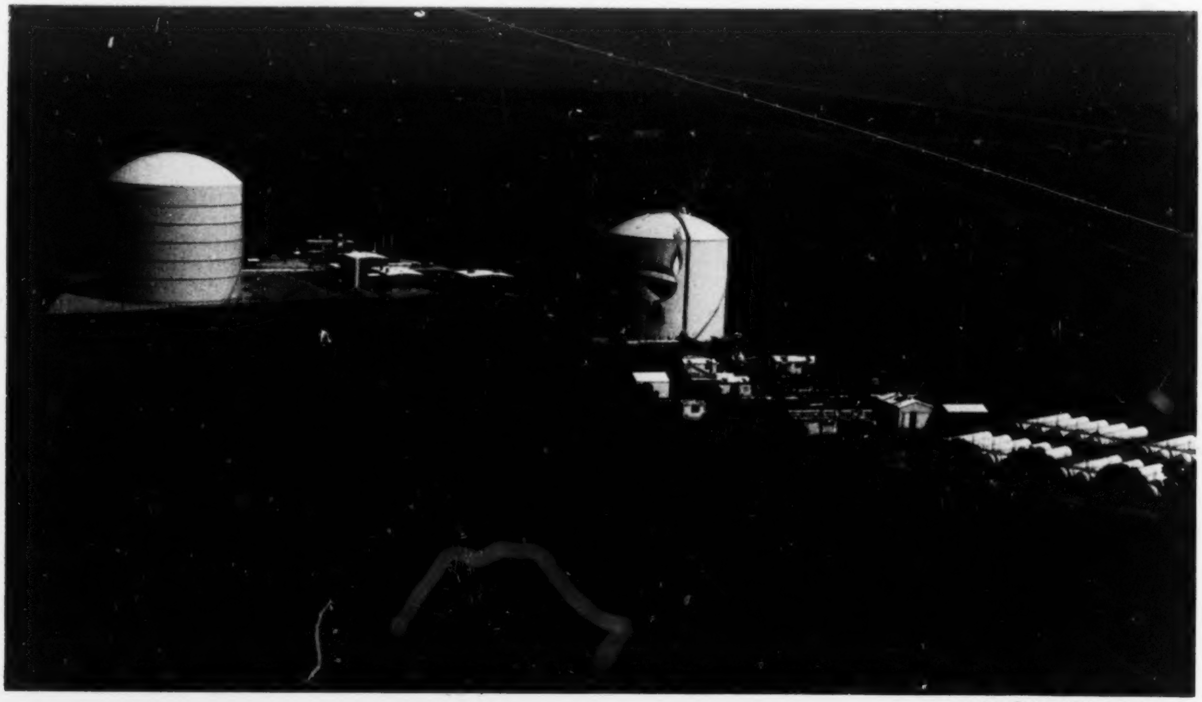
ity to develop Borchers North Field in Meade County, Kans., at a cost of $72,970,000. That would involve drilling and completing 30 new injection-withdrawal wells, working over 19 existing wells, installing 30 miles of field lines, and installing 15,000 hp in a compressor station. Total field capacity would be 70,082 MMcf, and maximum working capacity would be 35,000 MMcf.

Arkansas Louisiana Gas Co. plans to continue development in 1980 on Chiles Dome Storage Field in Oklahoma. Total project cost will be $30 million.

Battle Creek Gas Co. is developing the Cal-Lee fields for storage in Calhoun County, Mich., at a cost of $6 million.

El Paso Natural Gas Co. plans to develop the Washington Ranch Field in Eddy County, N.M., for gas storage at a cost of $53 million.

Consumers Power Co. is developing the Marsac Creek



—*courtesy Chicago Bridge and Iron Co.*

Burnsville, Minn., LNG facility of Minnesota Gas Co., *left*, in operation since 1978, is part of Minnegasco's comprehensive peakshaving operations at this location. At right are refrigerated storage (large tank with 'Minnegasco' painted on the side) and conventional storage for propane, used to manufacture propane-air for the utility system.

Field in St. Clair County, Mich., for gas storage.

Colorado Interstate Gas Co. is developing Flank Field for underground gas storage in Baca County, Colo., at a cost of approximately $17 million.

Equitable Gas Co. will continue development in 1980 of Shirley Field, Tyler County, W. Va.

Indiana Gas Co. continues to develop new underground gas storage and has two exploratory projects underway.

Northern Indiana Public Service Co. will spend $2 million on development of Grass Creek Field in Fulton, Pulaski, and Cass counties, Ind.

Southern California Gas Co. is developing Ten Section Field in Kern County, Calif., for underground gas storage. The $131 million project will be 50% owned by Pacific Gas and Electric Co.

Texas Gas Transmission Co. plans to spend approximately $2 million during 1980 to further develop its 10 gas storage fields in Kentucky and Indiana.

Propane-Air Plants

Propane-air plants in the U.S. now total 494 and are operated by 243 gas utilities in 40 states. Deliverability of these facilities has increased to 5.11 billion cu ft per day. An additional 12.3 million gal. of propane storage was added at new and existing propane-air facilities during 1979.

LNG Peakshaving Developments

Southwest Gas Corp. hopes to get construction of its planned $23,467,000 peakshaving facility underway in time to begin liquefaction in July 1981. This would enable Southwest to provide peakshaving in the 1981-82 heating season. Southwest had to abandon the original site it chose for the facility because of seismic considerations. If used, the site would not have been in compliance with the proposed federal regulations, under Part 193. An alternative site has been selected that is less seismically sensitive. CBI will build the facility.

Northern Indiana Public Service Co.'s second LNG peakshaving plant is now under construction at LaPorte, Ind. Completion is scheduled for September-October 1980. The facility is a "duplicate" of NIPSCO's existing plant. CBI expects to complete the LNG storage tank in early 1980 with completion of the liquefaction facility following during summer 1980.

Energy Terminal Services continues to process its application before the FERC to construct and operate a peakshaving plant at its Staten Island LNG terminal site. Congressman J. Murphy (D-N.Y.) appears to have extended his opposition to the use of the Staten Island facility as an LNG terminal to its use for peakshaving. The facility is located in his congressional district. Strangely enough, Congressman Murphy reportedly is not opposed to the siting of other facilities in urban areas provided they meet what he considers to be applicable safety standards.

The Department of Transportation's Materials Transportation Bureau (MTB) had not issued its new standards for LNG facilities as of the end of September. Staff was still reviewing the numerous comments submitted to its Notice of Proposed Rulemaking by the LNG industry and the public. The staff is also reviewing the report submitted by the Technical Pipeline Safety Standards Committee on the proposed standards. The MTB had hoped to issue regulations covering facility design and construction, Part 193, Subparts A-K, in September.

The Senate passed its bill S.411 Pipeline Safety Act of 1979, on June 4; H.R. 51, Fuels Transportation Safety Amendment Act of 1979, was expected to be passed by the House of Representatives in September. Both these bills modify the Natural Gas Pipeline Safety Act of 1968, which enables MTB to issue LNG regulations. Only the House version contains provisions calling for the Secretary of Transportation to issue new regulations covering both new and existing LNG facilities. The new regulations would add requirements in such areas as financial responsibility. **P&GJ**

SCORECARD U.S. and Canadian LNG Peakshaving Facilities November 1979

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	MBbl	Regasification – MMcfd: Total Design Capacity	Runs	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
APCI-NEGEA Hopkinton, Mass	18.5	2000 (2 at 290)	580	248	4 at 62	8	Submrgd	Aboveground, 9% nickel	CBI	Cryo-Methane	Cascade	1967—plant, 1971 on new tanks
APCI-NEGEA Hopkinton, Mass	—	1000	290	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1975—third tank
ALABAMA GAS CORP. Birmingham, Ala	4.65	625	180	127/85	3 at 42.5	10	Submrgd	Aboveground, 9% nickel	CBI	Air Products & Chemicals, Inc	Cascade	1965
ALABAMA GAS CORP. Birmingham, Ala	—	625	180	42.5	1 at 42.5		Submrgd	Aboveground, aluminum	CBI	—	—	1971—second tank
ALABAMA GAS CORP. Coosada, Ala	2.7	600	175	80	2 at 40	15	Submrgd	Aboveground, aluminum	CBI	CBI	Modified Cascade	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga	10.0	1000	290	200	3 at 100	5	Uniflux	Aboveground, aluminum	CBI	Air Liquide	TEAL Expander Process boost	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga		1500	450	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1973
ARKANSAS-MISSOURI POWER CO. Yarbro, Ark	0.66	374 (2 x 55)	110	66	2 at 33	6	Direct Fired	Aboveground, aluminum	Brown, Minneapolis Tank & Fab. Co	Process Constructors, Inc	Stirling	1973—(1972 as satellite)
BALTIMORE GAS & ELEC. CO. Baltimore, Md	2.75	500 (2 x 72.5)	145	187.5/125	3 at 62.5	5	Submrgd	Aboveground, aluminum	CBI	CBI	Expander	1971
BALTIMORE GAS & ELEC. CO. PLANT No. 2, Baltimore, Md	2.4	500	145	62.5	1 at 62.5	8	Submrgd	Aboveground, aluminum	CBI	CBI	MRL	1973
BAY STATE GAS CO. Ludlow, Mass	7.5	1000	290	55	1 at 25 2 at 15	20	Uniflux	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1973
BOSTON GAS CO. Boston, Mass	6.0	1000	290	187.5/125	3 at 62.5	8	Submrgd	Aboveground, 9% nickel	CBI	CBI	Expander	1968
BOSTON GAS CO. Boston, Mass	—	1120	331	—	—	—	—	Aboveground, aluminum	CBI	—	—	1971—second tank
BOSTON GAS CO. Lynn, Mass	7.85	1000	290	86.4/57.6	3 at 28.8	12	Submrgd	Aboveground, 9% nickel	PDM	Air Products & Chemicals, Inc	MCR	1972
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY Vancouver, B.C.	2.5	625	180	150/100	3 at 50	6	Submrgd	Aboveground, 9% nickel	Pittsburgh Des Moines Steel	Air Liquide	TEALARC	1971
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	5.68	625	175	100	2 at 50	4	Direct Fired	Aboveground, 9% nickel	CBI	American Messer	Expander	1968
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	—	1000	290	50	2 at 25	—	Direct Fired	Aboveground, 9% nickel	CBI	—	—	1971—second tank
				125 125	2 at 62.5 2 at 62.5	— —	Submrgd Submrgd					1979
CHATTANOOGA GAS CO. Chattanooga, Tenn	10.0	1200	348	90/60	3 at 30	20	Direct Fired	Aboveground, 9% nickel	PDM	J. F. Pritchard	PRICO	1973
CITIZENS GAS & COKE UTILITY Beech Grove, Ind	5.0	1000	290	180	3 at 60	5	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1972
COMMONWEALTH NATURAL GAS CO., Tidewater, Va	5.0	1200	348	105	3 at 35	12	Direct Fired	Aboveground, 9% nickel	PDM	Envirogenics	Cascade	1972
CONNECTICUT NATURAL GAS CORP., Rocky Hill, Con	6.6	1200	348	80/55	2 at 25 1 at 30	24	Vapor Trsfr Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1972
CONSOLIDATED EDISON CO. Astoria, N.Y.	6.0	1000	290	300/240	5 at 60	4	N.A.	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1974
DELMARVA POWER & LT. CO. Wilmington, Del	1.71	250	72.5	50	2 at 25	5	Direct Fired	Aboveground, aluminum	CBI	Lotepro-Linde AG	Expander/ Nitrogen	1972
EAST TENNESSEE NATURAL GAS CO. Fordtown, Tenn	5.5	1200	348	150	2 at 75	8	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1975
ENERGY TERMINAL SERVICES CORP., Staten Island, N.Y.	15.0	3000	900	360	4 at 90	8	Direct Fired	Prestressed concrete	Preload/Walsh	NA	NA	1982 planned
(Conversion of part of terminal capacity to peakshaving. Uses one of two storage tanks and all of vaporization capacity.)												
FALL RIVER GAS CO. Fall River, Mass	0.5	150	45	10	1	15	Direct Fired	Aboveground, 9% nickel	PDM	CVI Corp	Dual J. T. Cycle	1970
GAS LIGHT CO. OF COLUMBUS Columbus, Ga	1.7	500	145	60	2 at 30	8	Indirect Fluid	Aboveground, aluminum	CBI	CBI	Expander	1974
GAZ METROPOLITAIN, INC Montreal, Que., Canada	10.0	1000	290	180	3 at 60	16	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1969
GAZ METROPOLITAIN, INC Montreal, Que., Canada	—	1000	290	—	—	—	—	Aboveground, 9% nickel	Horton (CBI)	—	—	1972—second tank
INTERMOUNTAIN GAS CO. Boise, Idaho	4.0	600	175	90/60	3 at 30	10	Submrgd	Aboveground, aluminum	PDM	Lotepro-Linde AG	Expander/ Nitrogen	1974
IOWA-ILLINOIS GAS & ELEC. CO. Bettendorf, Iowa	2.0	500	145	50	2 at 25	10	Uniflux	Aboveground, aluminum	CBI	CBI	MRL	1972
IOWA POWER & LT. CO. Des Moines, Iowa	2.0	400	116	30	2 at 15	13	Intermed Fluid	Aboveground, aluminum	CBI	CBI	MRL	1975
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	2.5	400	117	30	2 at 15	26	Intermed Fluid	Aboveground, aluminum	PDM	APCO (prime) Air Liquide (liquefaction)	TEALARC	1976
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	—	400	117	—	—	—	—	Aboveground, aluminum	CBI	—	—	1978—second tank
KOKOMO GAS & FUEL CO. Kokomo, Ind	1.3	400	116	30/15	2 at 15	26	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1973
KOKOMO GAS & FUEL CO. Kokomo, Ind	1.25	—	—	—	—	—	—	(Second liquefaction unit)		CBI	MRL	1974
LONG ISLAND LIGHTING CO. Holbrook, N.Y.	3.0	600	175	200/150	4 at 50	4	Submrgd	Aboveground, 9% nickel	PDM	Lotepro-Linde AG	Cascade/ Mixed Refrigerant	1971
LOWELL GAS CO. Lowell, Mass	4.5	1000	290	70/70	2 at 30 1 at 10	16	Direct Fired	Aboveground, 9% nickel	Graver/ Envirogenics	Envirogenics	Expander	1969
MEMPHIS LIGHT, GAS & WATER DIV., Memphis, Tenn	5.0	1000	290	201	3 at 67	5	Submrgd	Aboveground, 9% nickel	CBI	Air Liquide	Cascade	1967
METRO. UTILITIES DISTRICT Omaha, Nebr	6.0	1000	290	60/30	2 at 30	33	Submrgd	Aboveground, 9% nickel	CBI	Lotepro-Linde AG	Expander/ Nitrogen	1975
MINNESOTA GAS CO. Burnsville, Minn	5.0	1000	290	80	2 at 40	12	Intermed. Fluid	Aboveground, 9% nickel	CBI	CBI	MRL	1978
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind	10.0	2000	580	300/200	3 at 100	10	Direct Fired	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1974
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind	10.0	2000	580	300/200	3 at 100	10	Submrgd	Aboveground	CBI	Lotepro	Mixed Refrigerant	1980—second facility—U.C.
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	2.5	625	180	85	3 at 42.5	7	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1968
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	—	—	—	—	1 at 42.5	—	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Lotepro Engr	—	1977
NORTHERN NATURAL GAS CO. Wrenshall, Minn	10.0	2165	630	200	2 at 100	10	Submrgd	Aboveground, 9% nickel	PDM	SD Plants	TEALARC	1975
NORTHERN NATURAL GAS CO. Ventura, Iowa	14.5	2165	630	300	3 at 100	7	Submrgd	Aboveground, 9% nickel	PDM	NNG	PRICO	1978
NORTHERN STATES POWER CO. Eau Claire, Wisc	2.0	270	78	24/24	2 at 12	11	Direct Fired	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHERN STATES POWER CO. Wescott, Minn	10.0	2000	580	75	2 at 37.5	28	Direct Fired	Aboveground, 9% nickel	CBI	CBI	MRL	1975
NORTHWEST NATURAL GAS CO. Portland, Ore	2.5	625	175	200	2 at 60 1 at 20 2 at 30	10	Direct Fired Submrgd	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHWEST NATURAL GAS CO. Newport, Ore	5.0	1200	348	100/100	2 at 50	12	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL/ CRYEX	1977
NORTHWEST PIPELINE CORP. Plymouth, Wash	6.0	1200	348	225	3 at 75	8	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1975
NORTHWEST PIPELINE CORP. Plymouth, Wash	6.0	1200	348	75	1 at 75	15	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1979
PEOPLES GAS, LIGHT & COKE Fisher, Ill	10.0	2000	580	300/200 (2 x 290)	3 at 67 1 at 100	10	Direct Fired	Aboveground, aluminum	CBI	CBI	Expander	1972
PHILADELPHIA ELECTRIC CO. West Conshohocken, Pa	6.6	1200	348	310/186	5 at 62	4	Submrgd	Aboveground, 9% nickel	CBI	Airco Cryoplants	Expander/ Nitrogen	1972
PHILADELPHIA GAS WORKS Philadelphia, Pa	25.0	4000	1166 (2 x 583)	500/400	5 at 100	10	Intermed Fluid	Aboveground, Prestressed concrete	Preload	J. F. Pritchard	Cascade	1969—Plant operable, 1974 on tanks
PIEDMONT NATURAL GAS CO. Charlotte, N. Car	5.0	1000	290	150	3 at 50	7	Direct Fired	Aboveground, 9% nickel	CBI	CBI	MRL	1973

Cont'd

U.S. and Canadian LNG Peakshaving Facilities

November 1979

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	MBbl	Total Design Capacity	Regasification — MMcfd Runs	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
PUBLIC SERVICE CO. OF NORTH CAROLINA, Cary, N. Car.	3.0	1000	290	100	2 at 50	6	Inter. Fluid	Aboveground, 9% nickel	CBI	CBI	MRL	1976
ROANOKE GAS CO. Roanoke, Va.	1.0	200	58.5	20	2 at 10	13	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	MRL	1972
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 1 Plant	2.0	625	175	120/60	2 at 60	10	Submrgd	Aboveground, 9% nickel	CBI	American Messer	Expander	1965
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 2 Plant	7.0	1200	348	180/120	3 at 60	10	Submrgd	Aboveground, 9% nickel	CBI	Airco Cryoplants	Expander/ Nitrogen	1970
SOUTH CAROLINA LNG CO. Bushey Park, So. Car.	6.0	1000	290 (2 x 145)	60	2 at 30	17	Intermed. Fluid	Aboveground, aluminum	PDM	APCO (prime) Air Liquide	TEALARC	1976
SOUTHERN CONNECTICUT GAS CO., Milford, Conn.	6.6	1200	348	90	2 at 30 1 at 30	14	Vapor Trsfr Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1972
SOUTHWEST GAS CORP. Deyton, Nev.	5.0	1000	290	105/70	3 at 35	10	N.A.	Aboveground 9% nickel	CBI	CBI	MRL	1981—Planned
TENNESSEE NATURAL GAS LINES, INC., Nashville, Tenn.	5.0	1000	290	150/100	3 at 50	10	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1973
TEXAS EASTERN TRANS. CO. Staten Island, N.Y.	7.65	2000	600	292/195	3 at 97.5	10	Direct Fired	Aboveground, 9% nickel, both walls	N.A.	Texas Eastern Cryogenics	TEALARC	1970; storage destroyed 1973; new double-wall tank—planned on same foundation
TRANSCANADA PIPELINES, Quebec City, Quebec, Canada	10.0	1000	300	125	NA	—	NA	Aboveground	NA	NA	NA	1983—Planned
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	7.0	1000	290	200/200	2 at 100	5	Intermed. Fluid	Aboveground, aluminum	CBI	J. F. Pritchard	Cascade	1965; 1970 on new tank
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	—	1000	290	200/200	2 at 100	—	Uniflux	Aboveground, 9% nickel	PDM	—	—	1974—second tank
UGI CORP. Temple, Pa.	2.0	250	73	30/30	3 at 10	8	Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander	1973 (197[illegible] as satellite)
UTILITIES BOARD Trussville, Ala.	5.0	400	116	20	2 at 10	—	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	MRL/ CRYEX	1976
WISCONSIN NATURAL GAS CO. Oak Creek, Wisc.	0.75	256	72	50/25	2 at 25	10	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	Cascade	1965

International LNG Peakshaving Facilities

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	MBbl	Total Design Capacity	Regasification — MMcfd Runs	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
BRITISH GAS CORP. Avonmouth, Avon	10.0	1000	290	270	3 at 90	4	Submrgd	Aboveground, aluminum	Whessoe, Ltd.	Cryoplants, Ltd.	MCR	1978—Plant 1979—Tank
BRITISH GAS CORP. Avonmouth, Avon	—	1000	290	180	2 at 90	—	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	—	—	1979—Second tank
BRITISH GAS CORP. Glenmavis, Scotland	5.0	1000	290	240	4 at 60	4	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Cryoplants, Ltd.	MCR	1979—(North Sea Gas)
BRITISH GAS CORP. Glenmavis, Scotland (2nd plant)	10.0	1000	290	120	2 at 60	17	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Cryoplants, Ltd.	MRC	1975
BRITISH GAS CORP. Partington, Cheshire, England	10.0	2000	580 (2 x 290)	450	5 at 90	4	Submrgd	Aboveground, 9% nickel	Wm. Neill & Son (St. Helens) Ltd. (PDM Lic.)	Cryoplants, Ltd.	MRC	1973
BRITISH GAS CORP. Partington, Cheshire, England (2nd plant)	10.0	2000	580 (2 x 290)	270	3 at 90	2	Submrgd	Aboveground, aluminum	Whessoe, Ltd.	Cryoplants, Ltd.	MRC	1974 on tank 1975 on plant
BRITISH GAS CORP. Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Petrocarbon Development Ltd.	Open/ Expander	1980—Planned
BRITISH GAS CORP. Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Aboveground, 9% nickel	Whessoe, Ltd.	Petrocarbon Development, Ltd.	Nitrogen Expander	1981—Planned
BRITISH GAS CORP. Dynevor Arms, S. Wales	10.0	1000	290	180	2 x 90	5	N.A.	Aboveground	N.A.	Snamprogetti	MCR	1983—Planned
BRITISH GAS CORP. Canvey Island, England	10.3	—	—	(Production plant only) (Reliquefaction)				—	—	Air Products, Ltd.	APCI-MCR	1972
N.V. NEDERLANDSE GASUNIE Maasvlakte, The Netherlands	12.4	2790	860 (2 x 430)	930	8 at 90 3 at 70	4	Submrgd	Aboveground, 9% nickel	Nederhorst Steel	Linde A.G.	Expander/ Nitrogen	1977
DISTRIGAZ, S.A. Zeebrugge, Belgium	12.3	2480	716 (2 x 358)	391	5	6	Submrgd	Aboveground, 9% nickel	Boelwerft/ CMP/CBI	Linde A.G.	Nitrogen/ Expander	1978
STUTTGART CITY UTILITIES Stuttgart, W. Germany	3.4	665	193	66.9	3	10	Submrgd	Aboveground, 9% nickel	Linde A.G.	Linde A.G.	Open Mixed Refrigerant	1971—Peakshaving plant
THYSSEN GAS GmbH Duisburg, Hamborn, W. Germany	2.1	550	145	135/90	3 at 45	5.5	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL	1976
GAS & FUEL CORP. OF VICTORIA Dandenong, Victoria, Australia	5.0	500	145	125	2 at 62.5	4	Submrgd	Aboveground, 9% nickel	CBI Pty. Ltd.	Cryoplants, Ltd.	MRC	1979—U.C.

EUROPEAN SATELLITE PEAKSHAVING FACILITIES

Company	Plant Location	LNG Source	Storage Volume MMcf	MBbl	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
British Gas Corp.	Ambergate, Derbyshire England	Imported LNG From Canvey Island	265	72	64	Field Erected aluminum	Whessoe, Ltd.	Whessoe, Ltd. (Helium Expander Reliquefaction)	1969
British Gas Corp.	Amlwch, Anglesey, Wales, U.K.	British Gas Corp. Glenmavis, Scotland	0.399	0.0117	0.360	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp. Wales Region	1975
British Gas Corp.	Stranraer, Wigtownshire, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	3.535	1.037	1.200	Shop fabricated, stainless steel	Cryoplants, Ltd.	British Gas Corp. Scottish Region	1973
British Gas Corp.	Oban, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	3.434	1.007	0.480	Shop fabricated, 2 tanks, stainless steel; 1 tank, 9% nickel	Clark Chapman, Ltd. Air Products, Ltd.	British Gas Corp. Scottish Region	1972
British Gas Corp.	Tohesay, Bate, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	4.545	1.332	1.200	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp., Scottish Region	1975
British Gas Corp.	Dunoon, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	6.060	1.777	1.920	Shop fabricated, 9% nickel	Air Products, Ltd.	British Gas Corp., Scottish Region	1973
British Gas Corp.	Dingwall Ross, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	1.768	0.518	0.360	Shop fabricated, stainless steel	Cryoplants, Ltd.	British Gas Corp., Scottish Region	1974
British Gas Corp.	Cambeltown, Argyll, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	4.545	1.332	0.960	Shop fabricated, 2 tanks, 9% nickel, 1 tank, stainless steel	Air Products, Ltd. Cryoplants, Ltd.	British Gas Corp., Scottish Region	1974
British Gas Corp.	Moffat, Dumfrieshire, Scotland, U.K.	British Gas Corp. Glenmavis, Scotland	1.763	1.763	0.350	Shop fabricated, stainless steel	Cryoplants, Ltd.	British Gas Corp., Scottish Region	1975
Gaz de France	Nantes, Loire-Atlantique France	Gaz de France LeHavre, France	50.3	15.7	17.0	Field erected, 1 tank, 9% nickel, 3145 bbl; 1 tank, concrete/invar, 12,579 bbl	Creusot—Loire Gaz Transport	Gaz de France	1966
Gaz de France	Granville, Manche, France	Gaz de France Le Havre, France	11.1	3.5	35.3	Field erected, 9% nickel	Bignier-Smidt-Laurent	Gaz de France	1976
Gaz de France	Saint Malo, Ille et Vilaine, France	Gaz de France Le Havre, France	5.0	1.6	35.3	Shop fabricated, 9% nickel (2 tanks)	l'Aire Liquide	Gaz de France	1975
Erdgas Sudbayern GmbH	Geretsried, W. Germany	Technische Werke der Stadt Stuttgart, W. Germany	2.1	0.629	1.7	Shop fabricated	Linde AG	Linde AG	1974

Cont'd EUROPEAN SATELLITE PEAKSHAVING FACILITIES

Company	Plant Location	LNG Source	Storage Volume MMcf	Storage Volume MBbl	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Technische Werke der Stadt Stuttgart	(Truck)	Technische Werke der Stadt Stuttgart, W. Germany	0.880	0.258	0.848	Truck transport	Linde AG and Aurepa	Technische Werke der Stadt Stuttgart	1976
Thyssengas GmbH	(Truck)	Thyssengas Duisberg-Hamborn W. Germany	0.645	0.189	0.848	Truck transport	Aurepa	Thyssengas	1977
Gas Figueras S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	4.385	1.26	0.056	Shop fabricated, stainless steel	Mecanica de la Pena	Erhan	1971
Gas Costa Brava S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	0.877	0.252	0.252	Shop fabricated, stainless steel	Maquinista Terrestrey Maritima	British Oxygen	1977
Gas Terraconense S.A.	Tarragona, Spain	ENAGAS Barcelona, Spain	1.315	0.378	0.112	Shop fabricated, stainless steel	Air Liquide Spain		1977
Sugranes Gres Catalan S.A.	Barcelona, Spain	ENAGAS Barcelona, Spain	5.262	1.512	0.196	Shop fabricated, stainless steel	Air Liquide Spain		1973
Colonia Guell S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	1.754	0.504	0.037	Shop fabricated, stainless steel	Maquinista Terrestrey Maritima	British Oxygen	1977
Gas Celra, S.A.	Gerona, Spain	ENAGAS Barcelona, Spain	1.315	0.378	N.A.	Shop fabricated, stainless steel	N.A.	N.A.	1977
Termica Cubellas	Tarragona, Spain	ENAGAS Barcelona, Spain	0.438	0.126	0.009	Shop fabricated, stainless steel	Air Liquide Espanola	Air Liquide Espanola	1978

NA = Not Available

LNG Satellite Peakshaving Facilities Small Capacity Plants—Shop Builtup Components

Company	Plant Location	LNG Source	Storage Volume MMcf	Storage Volume M gal	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Bay State Gas Co	Marshfield, Mass	Bay State, Distrigas	9.0	110	10.0	Shop builtup cylinders	Process Eng	Gas, Inc	1971
City of Brownsville Gas Dept	Brownsville, Tenn	Memphis LG&W	0.5	6	10.0	Trailer shuttle	Ryan Industries	City of B'ville Gas Dept	1970
Cape Cod Gas Co	South Yamouth, Mass	Lowell Gas Co	5.2	63.5	0.6	Shop builtup cylinder	Process Eng	Process Eng	1970
Cape Cod Gas Co	Wareham, Mass	Lowell Gas Co	9.0	110	2.9	Shop builtup cylinder	Process Eng	Gas, Inc	1974, 1978
Concord Natural Gas Corp	Concord, N.H.	Bay State Gas Co	4.5	55	4.8	Shop builtup cylinders	Process Eng	Gas, Inc	1974
Consumers Gas Co	Arnprior, Ont., Can	Gaz Metropolitan	4.5	55	4.8	Shop builtup cylinders	Process Eng	Gas, Inc	1978
DeKalb-Cherokee Counties Gas District	Fort Payne, Ala	Chattanooga Gas Co	4.5	55	2.2	Shop builtup cylinders	LOX Equip	Ladd Eng. Assoc	1972
Elizabethtown Gas Co	Hackettstown, N.J.	Transco	1.7	21	5.8	Shop builtup cylinder	Process Eng	PDM	1971
Fitchburg Gas & Electric Light	Westminster, Mass	Lowell Gas Co	4.5	55	5.0	Shop builtup cylinders	Process Eng	Gas, Inc	1974
Gas Service Inc	Nashua, N.H.	New England LNG	4.5	55	7.2	Shop builtup cylinders	Process Eng	Gas, Inc	1973
Holyoke Gas Department	Holyoke, Mass	Lowell Gas Co	18.0	220	12.0	Shop builtup cylinders	Process Eng	Gas, Inc	1971
Lawrence Gas Co	Lawrence, Mass	Lowell Gas Co	12.3	150	16.0	Shop builtup cylinder	H. L. Johnson	Gas, Inc and Smith & Norrington	1969, 1972
Lowell Gas Co	Wilmington, Mass	Lowell Gas Co	2.5	30	12.0	Shop builtup cylinders	H. L. Johnson	Gas, Inc	1971
Lowell Gas Co	Westford, Mass	Lowell Gas Co	4.5	55	6.0	Shop builtup cylinder	Process Eng	Gas, Inc	1972, 1974
Manchester Gas Co	Manchester, N.H.	New England LNG Co	4.5	55	6.0	Shop builtup cylinders	Process Eng	Process Eng	1975
Middleboro Gas & Electric Dept	Middleboro, Mass	Lowell Gas Co	2.5	30	5.0	Shop builtup cylinder	Process Eng	Gas, Inc	1970
Hartford Elec. Lt. Co	Torrington, Conn	Distrigas & New England LNG Co	4.5	56	3.0	Shop builtup cylinder	Ryan Industries	N. E. Utilities	1972
Hartford Elec. Lt. Co	Stamford, Conn	Distrigas & New England LNG Co	4.5	55	4.8	Shop builtup cylinders	Ryan Industries	N. E. Utilities	1972
Hartford Elec. Lt. Co	Danbury, Conn	Distrigas & New England LNG Co	9.0	110	3.6	Shop builtup cylinders	Ryan Industries	N. E. Utilities	1972
Connecticut Lt. & Power Co	Montville, Conn	Distrigas & New England LNG Co	4.5	55	2.2	Shop builtup cylinders	Process Eng	Gas, Inc	1972
Connecticut Lt. & Power Co	Waterbury, Conn	Distrigas & New England LNG Co	12.4	165	7.2	Shop builtup cylinders	Ryan Industries	N. E. Utilities	1972
Connecticut Lt. & Power Co	Norwalk, Conn	Distrigas & New England LNG Co	4.5	55	2.4	Shop builtup cylinders	Ryan Industries	Conn L&P	1975
Northern Utilities Inc	Lewiston, Me	New England LNG Co	12.4	165	7.2	Shop builtup cylinders	Process Eng	Applied Engineering Gas, Inc	1971, 1975, 1977
City of Norwich (Conn.) Dept. of Public Utilities	Norwich, Conn	New England LNG Co	4.5	55	7.2	Shop builtup cylinders	Process Eng	Gas, Inc	1972
Piedmont Natural Gas Company	Lenoir, N.C.	American LNG Corp	4.5	55	2.2	Shop builtup cylinders	Process Eng	Process Eng	1971
Savannah Public Utility Dept	Savannah, Tenn	Chattanooga Gas Co	0.85	11	1.5	Trailer shuttle	Process Eng	Process Eng	1973
United Cities Gas Co	Murfreesboro, Tenn	Chattanooga Gas Co	4.5	55	0.2	Shop builtup cylinders	Process Eng	Process Eng	1973
UGI Corporation	Hazleton, Pa (portable)	UGI Corp Temple, Pa	0.85	11	2.0	Trailer shuttle	Process Eng	Cosmodyne	1974
Westfield Gas Dept	Westfield, Mass	Lowell Gas Co	9.0	110	12.0	Shop builtup cylinders	Process Eng	Gas, Inc	1971, 1974
Wisconsin Gas Co	Rice Lake, Wis	Northern States Power	18.0	220	7.2	Shop builtup cylinders	Process Eng	Gas, Inc	1974
Middle Tenessee Natural Gas Authority	Smithville, Tenn	Memphis LG&W Div	1.8	22	0.08	Trailer Shuttle	American LNG Co	American LNG Co	1975

LNG Satellite Peakshaving Facilities Large Capacity Plants—Field Constructed K.D. Components

Company	Plant Location	LNG Source	Storage Volume MMcf	Storage Volume MBbl	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Atlanta Gas Light Co	Macon, Ga	Southern Energy	1500	450.0	150.0	Aboveground, aluminum	CBI	Applied Engineering	1977
Austell Gas Dept	Austell, Ga	American LNG Corp	80	23.3	20.0	Aboveground, aluminum sphere	CBI	CBI	1972
Bay State Gas Co	Easton, Mass	Distrigas	800	225.0	35.0	Aboveground, aluminum	CBI	CBI	1972
Boston Gas Co	Salem, Mass	Boston Gas	1000	290.0	30.0	Aboveground, 9% nickel	PDM	PDM	1972
Cape Cod Gas Co	South Yarmouth, Mass	Lowell Gas Co	175	51.5	20.0	Prestressed concrete w/liner	Walsh Construction	Gas, Inc	1971
Chicago Bridge & Iron Co	Cordova, Ala	American LNG Corp	45	13.0	3.5	Aboveground, aluminum sphere	CBI	CBI	1975
Elizabethtown Gas Co	Elizabeth, N.J.	Transco	150	45.0	30.0	Aboveground, aluminum	PDM	PDM	1971
Fort Hill Natural Gas Authority	Fort Hill, S.C.	American LNG Corp	35	10.0	12.0	Aboveground, aluminum sphere	CBI	CBI	1970
Haverhill Gas Co	Haverhill, Mass	Distrigas	400	114.0	24.0	Aboveground, aluminum	CBI	CBI	1972

Cont'd LNG Satellite Peakshaving Facilities Large Capacity Plants—Field Constructed K.D. Components

Company	Plant Location	LNG Source	Storage Volume MMcf	Storage Volume MBbl	Sendout Capacity MMcf/day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Lynchburg Gas Co	Lynchburg, Va.	Roanoke Gas Co.	42	12.0	7.2	Aboveground, aluminum sphere	Graver	Gas, Inc.	1976
New Bedford Gas & Edison Light Co.	Acushnet, Mass.	Hopkinton LNG Corp.	200	58.0	30.0	Aboveground, 9% nickel	PDM	Air Products	1971
New Bedford Gas & Edison Light Co	Acushnet, Mass.	Hopkinton LNG Corp.	300	87.0	—	Aboveground, aluminum	CBI	—	1973 (2nd tank)
New Jersey Natural Gas Co	Stafford Township, N.J.	Distrigas	100	28.5	20.0	Aboveground, aluminum	CBI	CBI	1971
New Jersey Natural Gas Co.	Howell Township, N.J.	Distrigas	400	117.0	60.0	Aboveground, aluminum	PDM	PDM	1974
Northern States Power Co.	Wescott, Minn.	NSP, Eau Claire, Wis.	130	32.0	24.0	Aboveground, aluminum	CBI	CBI	1972
Northern States Power Co.	LaCrosse, Wis.	NSP	130	37.0	12.0	Aboveground, aluminum	CBI	CBI	1969
Philadelphia Gas Works	Philadelphia, Pa.	PGW	250	73.0	88.8	Aboveground, 9% nickel	PDM	Envirogenics	1971
Providence Gas Co.	Exeter, R.I.	Distrigas	198	55.0	24.0	Aboveground, aluminum	Graver/ Envirogenics	Envirogenics	1972
Public Service Gas & Electric Co.	Burlington Township, N.J.	Distrigas	350	100.0	75.0	In-ground, aluminum	CBI	Envirogenics	1972
Springfield Gas Utility	Springfield, Tenn.	Various	20	5.0	4.8	Aboveground, aluminum sphere	PDM	PDM	1974
South Jersey Gas Co.	McKee City, N.J.	Distrigas	400	116.0	60.0	Aboveground, aluminum	CBI	CBI	1972
Valley Gas Co.	Cumberland, R.I.	New England LNG Co.	87	25.0	12.5	Prestressed concrete w/liner	LNG Co.	Gas, Inc.	1971

International Baseload LNG Liquefaction Facilities

Company and Plant Site	Liquefaction Plant Capacity, MMcf/day	Storage Capacity, MMcf	Storage Capacity, MBbl	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
ARCTIC PILOT PROJECT Bridport Inlet, Melville Island, Canada	275 (Barge-mounted)	NA	NA	NA	N.A.	N.A.	Precooled TEALARC	1983
CAMEL Arzew, Algeria	200.0	1840 total	210 (3x70) 310	Aboveground, (2-aluminum, 1-9% nickel) Frozen hole	CBI lic. Pritchard	TECHNIP Pritchard	Cascade	1963 et seq. LNG for export to England, France
SONATRACH (LNG-1) Arzew, Algeria	1100.0	7000	1890 (3 x 630 tanks)	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Bechtel Corp. & Chemico	APCI-MCR	1978
SONATRACH (LNG-2) Arzew, Algeria	1000	6000 (3 x 600)	1800	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Pullman Kellogg	APCI-MCR	1980—U.C.
SONATRACH (LNG-3) Arzew, Algeria	1800	N.A.	N.A.	Aboveground	N.A.	Foster-Wheeler	TEALARC	1982—U.C.
SONATRACH—Phase 1 Skikda, Algeria	430.0 (3 trains)	2500	700 (2 x 350)	Aboveground, 9% nickel	CMP/CBI	TECHNIP	TEALARC	1972—export to France
SONATRACH—Phase II Skikda, Algeria	170.0 (1 train)	1250	350	Aboveground, 9% nickel	CBI	Pullman-Kellogg	PRICO	1979
SONATRACH—Phase III Skikda, Algeria	350.0 (2 trains)	3500	880 (2 x 440)	Aboveground, 9% nickel	CBI/Whessoe	Pullman-Kellogg	PRICO	1979—U.C.
ESSO LIBYA Marsa el Brega, Libya	385.0	2100	630 (2 x 315)	Aboveground, 9% nickel	CBI	Esso R&E-Bechtel—SNAM Progetti	APCI-MCR	1970
BRUNEI LNG Lumut, Brunei, Borneo	750.0	4050	1131 (3 at 377)	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Japan Gasoline Co.—UOP	APCI-MCR	1973
ABU DHABI GAS LIQUEFACTION CO. LTD., Das Island, Abu Dhabi	350.0	6600	1920 (2 x 960)	Aboveground, 9% nickel	I.H.I.	Bechtel-Chiyoda	APCI-MCR	1977
PHILLIPS-MARATHON Kenai, Alaska	155.0	2300	675 (3 at 225)	Aboveground, aluminum	CBI	Phillips-Bechtel	Cascade	1969
PACIFIC ALASKA LNG. CO. Cook Inlet, Alaska	400.0	3000	1100 (2 x 550)	Aboveground 9% nickel	CBI	Fluor Corp.	APCI-MCR	1982—Planned
PERTAMINA/MOBIL Arun, N. Sumatra, Indonesia	1200	8350	3200 (4 x 800)	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Bechtel, Inc.	APCI-MCR	1978
PERTAMINA/HUFFCO Badak, E. Kalimantan, Indonesia	550	8330	2400 (4 x 600)	Aboveground, 9% nickel	Hitachi Zosen—CBI	Bechtel, Inc.	APCI-MCR	1977
GAS DE CHILE (ENAP) Cabo Negro, Chile	250	N.A.	N.A.	N.A.	N.A.	APCI	APCI-MCR	1984—Planned
EL PASO ALASKA, INC. Point Gravina, AK.	3375 (8 trains)	6000	2200 (4 x 550)	Aboveground, 9% nickel	N.A.	Phillips Petroleum	"Optimized" cascade	1980—Planned
PETRONAS/MITSUBISHI/ROYAL DUTCH SHELL Bintulu, Sarawak, Malaysia	850	N.A.	N.A.	Aboveground	N.A.	N.A.	N.A.	1981—Planned
BONNY LNG Bonny, Nigeria	2000	(nominal)	N.A.	N.A.	N.A.	Phillips	"Optimized" cascade	1980's—Planned
NATIONAL IRANIAN GAS CO. Kangan, Iran	400	6000 (3 tanks)	1800	Aboveground, 9% nickel	N.A.	N.A.	APCI-MCR	1983—Planned
NATIONAL IRANIAN GAS CO. Kangan, Iran	400 (Barge-mounted)	3580	1038	Barge-mounted, aluminum spheres	Moss-Rosenberg Verft	N.A.	APCI-MCR	1983—Planned
NATIONAL IRANIAN GAS CO./ FORMER KALINGAS ASSOCIATES Kangan, Iran	400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1980's—Planned
WOODSIDE LNG PTY. LTD. Withnell Bay, Western Australia	900	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1985

LNG Satellite Facilities In Japan

Company	Plant Location	LNG Source	Storage Volume MMcf	Storage Volume MBbl	Sendout Capacity MMcf/Day	Type of Storage Container	Storage Contractor	Systems Contractor	Year of Operation
Tokyo Gas Co	Hitachi, Ibaragi	Tokyo Gas Co. Negishi/Sodegaura	31.3	9.20 (1x8.82) (1x0.38)	133 2 x 22 1 x 89	Field erected Shop fabricated	Hitachi Nippon Oxygen	Tokyo Gas Company	1970
Washinomiya Gas Co	Washinomiya, Saitama	Tokyo Gas Co. Negishi/Sodegaura	0.77	0.226 (2x0.113)	33 3 x 11	Shop fabricated	Toyo Oxygen	Tokyo Gas Company	1971
Sioei Gas Co	Higashimatsuyama Saitama	Tokyo Gas Co. Negishi/Sodegaura	0.43	0.126 (2x0.063)	10 2 x 5	Shop fabricated	Nippon Oxygen	Tokyo Gas Company	1975
Miho Gas Co	Miho, Ibaragi	Tokyo Gas Co. Negishi/Sodegaura	1.29	0.378 (3x0.126)	66 3 x 22	Shop fabricated	Nippon Oxygen	Tokyo Gas Company	1977

U.S. Remote Supply Projects

Company	Plant Location	Origin of Liquid	Site Storage, M gal	Site Vaporization, Mcf/hr
San Diego Gas & Electric Co.	Borrego Springs, Calif.	Peakshaving facility at Chula Vista, Calif.	7.75	9
San Diego Gas & Electric Co.	Alpine Village, Calif.	Peakshaving facility at Chula Vista, Calif.	25	30
San Diego Gas & Electric Co.	Camp Pendleton, Calif.	Peakshaving facility at Chula Vista, Calif.	50	90

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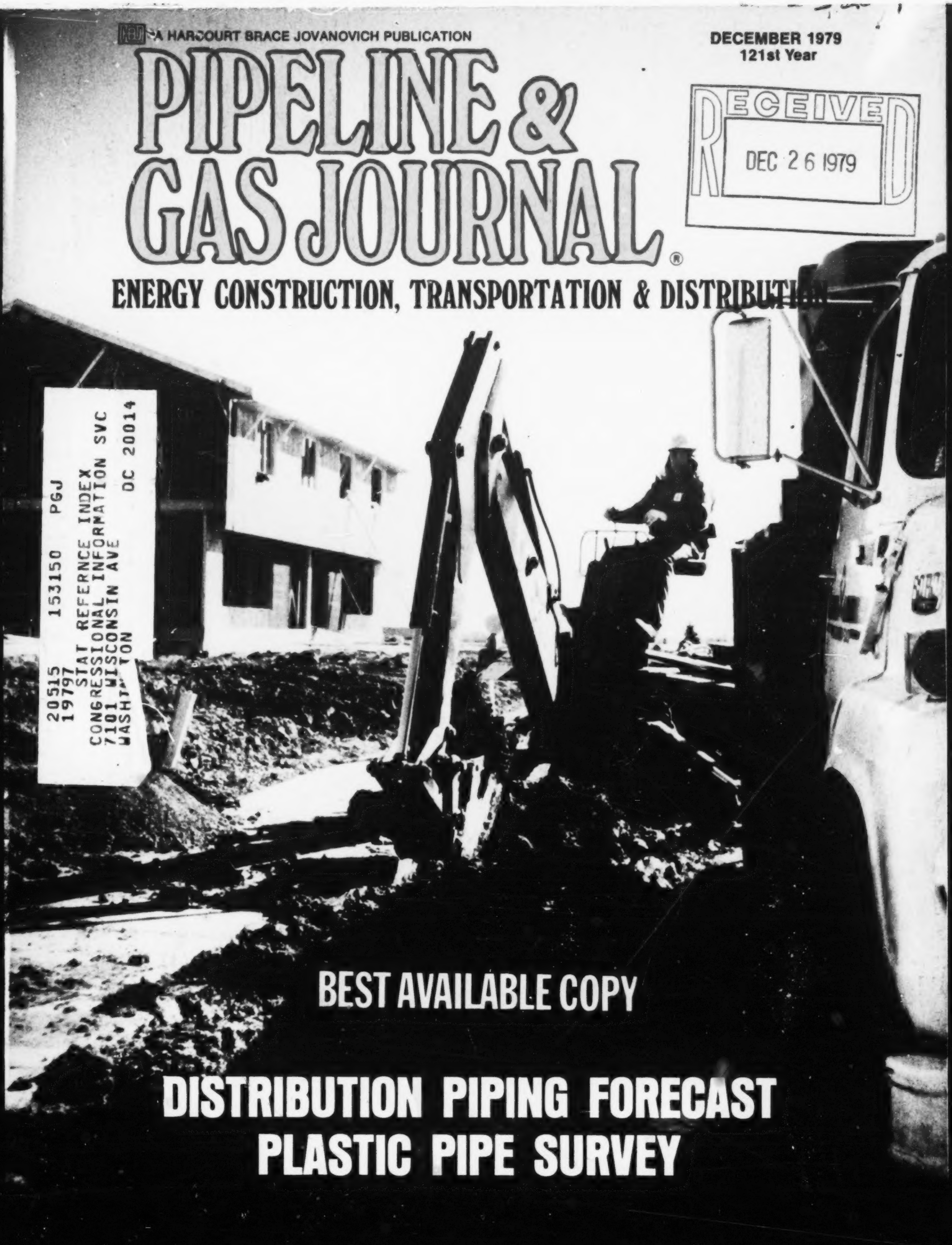

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DISTRIBUTION PIPING FORECAST
PLASTIC PIPE SURVEY

PIPELINE & GAS JOURNAL
International Pipeline & Gas Utility Design, Construction & Operation

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THE COVER
Wisconsin Gas Company distribution crew member cuts ditch for new gas main representative of the growth during 1979 of the nation's gas distribution business.
—Photo Courtesy Wisconsin Gas Company

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Expenditures for 1980 seen as nearly 10% above 1979 levels, with 26,971 miles of new and replacement mains and services to be installed.

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Gas piping is dominated by plastic — nearly 70% of all 1979 piping is plastic — with 18,843 miles to be installed by the end of 1979.

Live Insertion For Renewals Permits Simultaneous Operation 20
New method allows renewed lines to operate at higher pressures than for those lines; existing main pressure is maintained during renewal pipe insertion.

Training Instructors Key To New Plastic Pipe Rules 24
New DOT-MTB regulations require company crews and contractor personnel to be trained in all aspects of plastic pipe installation; comprehensive training program for company instructors is major step in qualifying field personnel.

Southern Union Programs Plastic Pipe For Mains and Services 26
Major southwestern utility has embarked on a program to emphasize PE pipe usage in its gas distribution system for the future.

Far Northern Canadian Utility Plowing-In Gas Piping System 30
Athabasca County Utility Committee has installed 900 miles of PE pipe in its service area, mostly by plow-in.

Programmable Controllers For Pipeline Pump Stations 36
New approach to monitoring and controlling oil pipeline pump stations applies solid-state electronics in form of programmable logic controllers; Seaway Pipeline's is a prime example.

ISAM System Solves Network Problems For Lone Star Gas 44
Solution of routine gas distribution system analysis problems by ISAM (Integrated System Analysis Model) provides for future growth, solves low-pressure problems, locates restrictions, etc.

Linalog Survey Pig Squeals On Pipe Defects 53
Ashland Pipeline Co. reduces downtime and facilitates maintenance and repair using information gathered by internal pipe surveys.

Gas Distribution Forecast

—*Photo courtesy Wisconsin Gas Co.*

Record $1.704-billion expenditure forecast for 1980 for the gas distribution utilities will involve both new main and service construction, and a large amount of replacement work on both mains and services, as typified by this Wisconsin Gas Co. crew busy replacing a main section.

Gas Utilities See $1.7 Billion Year

by Dean Hale, *Editor*

Gas distribution utilities added new customers in 1979 – almost with a vengeance – as demands for gas to replace costly oil and electric heating rose in the northern and northeastern states. As a result, 1980 is expected to be a record year.

In terms of expenditures, PIPELINE & GAS JOURNAL's 14th annual survey of gas distribution utilities projects $1.704-billion for new and replacement mains and services and for system maintenance in 1980.

That figure is 9.3% above the record $1.558-billion spent during 1979 for new and replacement mains and services and system maintenance – and 1979 represented an increase of 13.8% over 1978 expenditures.

The record dollar expenditure forecast for 1980 is result of two major factors: 1) more people want gas, and the required extensions will cost more money; 2) inflation takes its toll in increased material and labor costs that the gas utilities must pay to advance service to new areas and new customers.

And, as noted in previous years' surveys, the nation's burgeoning bureaucracy hasn't declined in size or impact, and all those federal, state, and local regulations likewise take a monetary toll.

With restrictions removed on customer additions in nearly all areas of the nation, and with gas supplies improving almost daily, the gas distribution industry expects to install 26,971 miles of new and replacement mains and services by year's end (and will have spent $1,005,407,200 to do it – an increase of 13.8% above 1978 expenditures).

System maintenance expenditures continue to climb – up 14%, with gas utilities spending a total $553,183,380 in that area of operations.

More than 810,000 new customers are expected to be added to the rolls by the end of the year, an increase of 35% over the number added in 1978. Total number of customers expected to be served on December 31, 1979, is more than 46,000,000.

Gas utilities expect to add another 700,000 or more customers during 1980, provided the economy doesn't collapse completely and a relatively high level of housing starts persist. Despite high costs, it appears that new housing is widely sought and that economical natural gas is the preferred home-heating, cooking, and water-heating fuel. As noted earlier, there is strong demand in many areas of the country for gas service to replace increasingly expensive oil heat or electric heat.

Projections for 1980, based on returns to P&GJ's survey, show that 27,246 miles of new piping – including 13,448 miles of new and replacement mains and 13,798 miles of new and replacement services – will be installed.

Expenditures for new and replacement mains and services in 1980 are forecast to be $1,126,107,400, while outlays for system maintenance will be $578,526,600. (All projections are in 1979 dollars.)

Data for projections on 1979 and 1980 expenditures and pipe mileage were compiled in a survey of 500 leading gas utilities in 50 states. Responses on expenditures, planned installations, and operating and engineering conditions were supplied by utility management, engineering, and operating personnel.

Supply Seldom A Problem

Because supply in recent years has restricted orderly gas distribution utility development, and improved supply conditions during 1979 appeared to be stimulating industry growth in a measurable fashion, PIPELINE & GAS JOURNAL's 14th annual survey asked respondents to comment on gas supply conditions and customer attachment policies. The responses included:

"We continue to add customers without regard to supply. No problems."

"With greater supplies, we have restrictions on very large customers only."

"We now have an aggressive sales campaign to attract new heating customers through conversions and we are attaching hot water-heating loads."

"Our gas supply is more than adequate to meet our immediate needs."

"Began, as of February 1, 1979, taking on heating-only customers. As of March 1, 1979, all customers have to pay for service lines."

"No large industrial loads are being connected."

"Began attaching residential customers and commercial and industrial non-boiler loads in February, after a 2½-year period of no growth."

"Have been able to eliminate applicant waiting lists for residential space heating and small commercial users."

Gas Distribution Utility Expenditures

	Expenditures	
	1979	1980
New and replacement mains and service lines . .	$1,005,407,200	$1,126,107,400
Maintenance of system . . .	553,183,380	578,526,600
TOTALS	$1,558,590,580	$1,704,634,000

Gas Distribution Utilities Pipe Installed

	Piping Installed, Miles		
	1978	1979	1980
Gas mains	10,233	13,319	13,448
Gas service lines	11,555	13,652	13,798
TOTALS	21,788	26,971	27,246

Gas Distribution Utilities— Pipe Installed—Total "In Ground"

Gas Mains	806,625
Gas Service Lines	498,034
TOTAL	1,304,659

"No restrictions. Have more gas allotted than we can sell."

"No change in customer attachment policies. We have always had plenty of gas."

"Service is available to all customers under 5 Mcf rating under our extension rule."

"Large industries that could use alternative fuels such as coal have done so. Others that could not have changed to firm contracts."

"Conservation has permitted attachment of more new residential customers."

"Thanks to customer conservation measures and loss of certain large industrial boiler loads, gas is now available for residential and light commercial usage. These customers are being attached without reservations at this time."

More Construction, Maintenance Expected

Survey respondents were also asked to comment on changes in construction and maintenance programs resulting from changes in gas supply and expanded marketing programs. Responses included:

"1980 appears to be an 'up' year – we'll add more customers in both 1980 and 1981."

"More construction was experienced in 1979, and 1980 will be even more active."

"Anticipate more business, therefore more construction-budget dollars. No change in maintenance program."

"Expanded construction program forced us to buy more equipment and more materials."

"New construction is down slightly, but we have greatly increased maintenance programs because men and equipment are available."

"No major changes in our programs."

"Increased programs in 1979 and 1980. Maintenance program right on schedule."

"We are well over budget in 1979."

"We anticipate a 300% increase in new gas customers."

"Our company has experienced a materials and manpower shortage as result of rapid increase of new-business requests. Maintenance program has suffered slightly for the same reasons. Hopefully, the 1980 year will bring better material supplies and more available manpower."

"Overall, new construction has tripled."

"Dramatic increase in 1979 new construction due to our strong gas supply situation. Rise in cost of home heating oil has helped us. We expect this high activity level to continue through 1980."

"Far more inquiries and applications for service than ever anticipated."

"Construction programs have increased significantly."

P&GJ

Plastic Pipe Revolution

Plastic pipe – especially polyethylene pipe – now dominates the new and replacement gas piping market. For the sixth year in a row, plastic pipe accounts for more than half of all pipe used by gas distribution utilities.

During 1979, plastic pipe accounts for 69.8% of all piping material used, according to PIPELINE & GAS JOURNAL's annual gas distribution piping survey.

Tabulated responses show that the industry will install 99,491,049 ft (18,843 miles) of plastic pipe and tubing of all sizes and types by the end of 1979. In terms of footage, it is the best year ever for plastic pipe.

For 1980, projected plastic pipe mileage is 21,260 miles – approximately 78% of the 27,246 miles of new and replacement mains and services foreseen to be installed during the coming year.

Total plastic pipe mileage installed by U.S. gas distribution utilities is now 154,276 miles. Latest records show that 925 gas utilities are using plastic pipe of some type. Of that number, 65 are considered major users, having more than 750,000 ft of plastic pipe installed.

Of all piping installed for the utility delivery of gas, plastic pipe now represents 12.08%.

Plastic pipe usage, expressed as a percentage of all gas distribution piping installed each year, continues to increase:

- 1966 . . . 12.0% was plastic
- 1967 . . . 13.5% was plastic
- 1968 . . . 16.5% was plastic
- 1969 . . . 19.0% was plastic
- 1970 . . . 21.2% was plastic
- 1971 . . . 24.9% was plastic
- 1972 . . . 31.3% was plastic
- 1973 . . . 42.2% was plastic
- 1974 . . . 50.6% was plastic
- 1975 . . . 55.8% was plastic
- 1976 . . . 54.5% was plastic
- 1977 . . . 72.2% was plastic
- 1978 . . . 66.9% was plastic
- 1979 . . . 69.8% was plastic
- 1980 . . . 78.0% projected to be plastic.

Usage Trends

Plastic pipe for new and replacement mains represented 46.1% of the total amount of plastic pipe installed in 1979. Plastic pipe used for new and replacement services represented 53.8% of the total for 1979. Only 0.1% was used for other applications – gas lights, gas grills, regulator vault vents, and cathodic protection test stations.

Of the companies reporting use of plastic materials, 88.1% are using plastic pipe for new and replacement mains, and 90.7% are using plastic for new and replacement services.

Polyethylene dominates the market. Polyethylene – grades 2306, 3306, or 3406 – is used by 95.1% of all companies installing plastic pipe today. P&GJ's survey concludes that 71.8% use PE 2306, 36.9% use PE 3306 or PE 3406, 5.8% use PVC, 1.9% use polybutylene, and 0.9% use ERF. No other types appear to be in use today.

Of the grand totals of piping installed, as compiled from survey responses, 46.9% of the plastic piping now in use is 1-in. and under in size, 41.5% is in the 1¼-in.-to-2-in. range, 7.5% is 3-in., 3.4% is 4-in., and 0.7% is larger than 4-in.

Plastic Brings Changes

P&GJ's 1979 survey of plastic piping asked users if they were using more plastic pipe and how use of plastic had changed procedures and equipment requirements for con-

Sizes of Plastic Installed (% of Total) by Gas Distribution Utilities

Size (Inches)	% Total 1978	% Total 1979	% Total 1980
¾ and under	53.0	55.1	51.6
1 to 2	34.3	36.3	40.1
3	3.6	3.6	3.4
4	4.3	4.2	4.2
6 and over	0.8	0.8	0.7

Keeps Growing

by Dean Hale, *Editor*

struction/maintenance/repair. Here are some typical answers:

"Plastic pipe allows for less bulky, lighter, and 'hopefully' less-expensive equipment to handle material."

"We have used only plastic pipe since 1968, and our procedures stay much the same. Some more advanced equipment has been added from time to time."

"We plan to use more plastic pipe in the future."

"Have used plastic pipe from 1960 to date."

"Use plastic principally for insert renewals,"

"Plastic is our primary distribution material. We standardized on plastic pipe in 1968."

"Use plastic for 95% of our new piping and 85% of our replacement piping. Butt-fusion has been approved and will require new equipment."

"We are going to PE 3406 as PVC is no longer available."

"Have been using plastic pipe for 95% of all new mains and service installations for over 10 years."

"We are using more plastic pipe, but it has no effect on our procedures or equipment requirements, as we use outside contractors exclusively."

"About 90% of pipe installed is plastic. It requires less heavy equipment but increasing amounts of procedural training."

"Using more plastic. Repairing more dig-ins. We are equipping our crews for plastic construction and repair of plastic lines. Have big problem keeping our weldors on steel qualified because of not-enough steel construction."

"Use more plastic. In many ways has reduced equipment requirements,"

"Recently we began using 6-in. plastic pipe – it requires new and larger fusion equipment, and we are also introducing fusion techniques to service men who will soon be performing jobs that were previously handled by construction crews."

"We are now able to use smaller crews due to lesser weight of plastic (vs. steel), plus a weldor is not required."

"All new piping 3-in. and under is plastic, and use of plastic has increased our ability to do a portion of our own construction."

"No significant change in procedures or equipment requirements even though we have increased number of extensions to serve new customers."

"Utilizing plows to greater extent for service installations with more emphasis on plastic joining tools and on training and equipment."

"Bought all new tools and equipment for plastic, including tools for squeeze-off for repairs and tie-ins."

"Our conversion to plastic required substantial changes in procedures and equipment."

"We are expanding the use of plastic pipe in large sizes. All of our vehicles are equipped to handle plastic installations for new construction or repairs."

"More plastic is being used now, and this trend should continue to increase."

"Have been about 80% plastic for the past five to seven years. Major change has been from socket to butt-fusion a few years ago."

"We are going to an all-plastic system, up to 4-in; training and equipment requirements are gearing up for it."

"Use of plastic has reduced crew size – four-man crews to two or three men, and that has allowed change in basic, crew truck cab and chassis from expensive tilt-cab model to conventional cab."

P&GJ

1979 Gas Distribution Utility Usage of Plastic Pipe

Type of Installation	% of Total
New Mains	22.8
Replacement Mains	23.3
New Services	28.8
Replacement Services	25.0
Other Applications (gas lights, grills, etc.)	0.1

Profit Margins Edge Up

by Julie Fonner, *Assistant Editor*

Increased production of oil and natural gas in the United States – and all over the world – accounted for many oil/gas companies' earnings increases for the third quarter of 1979.

Our survey of oil companies' third quarter results shows an increase in profit margin to 6.0% from 4.5% in the 1978 quarter. Return on revenues for the nine months is 6.0%, up from 4.5% in 1978.

Superior Oil, nation's largest producing oil/gas company having no refining or marketing operations, said increased production and higher prices contributed to its profits increase over the 1978 third quarter.

Crystal Oil, Noble Affiliates, Belco Petroleum, Crestmont Oil & Gas, Mesa, Natomas and Southland Royalty all said higher prices for oil and gas and increased production resulted in earnings increases.

North Slope production is increasing for Atlantic Richfield, and with improved wellhead prices allowed by government, ARCO reported increased earnings for the 1979 third quarter. Worldwide profits on products sold were 1.6¢ per gallon.

Sohio's Alaskan operations contributed biggest share to their earnings. Coal operations "continue to suffer from operating and productivity problems."

Cities Service said nine-months earnings rise resulted from oil/gas production, natural gas liquids, refining, marketing and minerals operations.

Diamond Shamrock and Quaker State reported improved earnings in coal operations. Conoco's coal earnings declined.

Conoco's 134% increase in earnings for the third quarter over 1978 can be "attributed almost entirely to foreign petroleum operations." Conoco's profit on a gallon of refined products sold was 1¢ per gallon, the same as in the 1978 period. Conoco's 134% increase in earnings means a return of 7.1%.

Mobil reports an increase in profits on products sold from 2.1¢ per gallon in 1978 to 3.4¢ per gallon worldwide.

Standard California's profits on products sold worldwide were 2.9¢ per gallon in 1979 nine months; profits on U.S. sales were 2.5¢/gal.

Gulf says two-thirds of its earnings increase occurred in foreign operations. A 97% increase in profits for the third quarter reflects return on revenues of 6.2¢/$1 of revenues in 1979 compared to 4.2¢/$1 revenues in 1978 third quarter.

Gas utility company return on revenues for 12 months ending September 30 was 5.5% compared to 6.1% in 1978 period.

Alabama-Tennessee Natural Gas' earnings increase because of more gas supplies ... United Energy Resources said improved supplies helped their earnings also.

El Paso attributes earnings rises to "continued buildup of LNG deliveries" to the U.S. East Coast, natural gas operations and chemical subsidiary improvements.

THIRD QUARTER NATURAL GAS COMPANIES FINANCIAL REPORTS

	Three months ending September 30**						Twelve months ending September 30**						Profit Margin‡	
	Revenues ($000)			Earnings* ($000)			Revenues ($000)			Earnings* ($000)				
Company	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978
Alabama Tennessee N.G.	20,136	9,517	+111.6	1,446	1,074	+ 34.6	58,031	37,120	+ 56.3	4,346	2,956	+ 47.0	7.5	8.0
Alberta Gas Trunk Lines							767,970[1]	346,039[1]	+121.9	78,692[1]	56,336[1]	+ 39.7	10.2	16.3
American Natural Resources	482,676	386,813	+ 24.8	(13,462)	(154)	-8641.6	2,337,446	2,030,888	+ 15.1	99,922	143,083	- 30.2	4.3	7.1
Arkansas Louisiana Gas	178,430	109,563	+ 62.9	11,260	6,267	+ 79.7	663,843	519,998	+ 27.7	61,583	53,027	+ 16.1	9.3	10.2
Coastal States Gas	1,339	908	+ 47.5	30	11	+172.7	3,836[1]	2,855[1]	+ 34.4	85[1]	42[1]	+102.4	2.2	1.5
Columbia Gas	455,584	373,515	+ 22.0	(2,858)	(2,909)	+ 1.8	2,642,456	2,407,822	+ 9.7	137,838	129,652	+ 6.3	5.2	5.4
Commonwealth Nat. Res.	31,094	21,672	+ 43.5	606	62	+877.4	139,409	117,960	+ 18.2	4,825	3,470	+ 39.0	3.5	2.9
Consolidated Nat. Gas	303,598	203,498	+ 49.2	(995)	(1,024)	+ 2.8	1,850,898	1,545,210	+ 19.8	110,118	98,748	+ 11.5	6.1	6.4
El Paso Company	835,955	516,869	+ 61.7	38,497	24,003	+ 60.4	2,187,821[1]	1,449,246[1]	+ 51.0	110,419[1]	71,527[1]	+ 54.4	5.0	4.9
Enserch Corp.	572,387	403,203	+ 42.0	18,990	8,830	+115.1	1,640,417[1]	1,289,659[1]	+ 27.2	73,372[1]	58,284[1]	+ 25.9	4.5	4.5
Equitable Gas							256,724	210,550	+ 21.9	23,786	15,055	+ 58.0	9.3	7.2
Houston Nat. Gas[2]							1,797,835	1,554,002	+ 15.7	138,108	130,047	+ 6.2	7.7	8.4
Kansas Nebraska Nat. Gas	78,337	73,209	+ 7.0	3,544	5,096	- 30.5	308,889	271,941	+ 13.6	18,008	21,041	- 14.4	5.8	7.7
Mountain Fuel Supply							314,158	270,802	+ 16.0	20,899	21,808	- 4.2	6.7	8.1
Northern Nat. Gas	514,885	375,883	+ 37.0	20,116	13,229	+ 52.1	2,262,271	1,866,101	+ 21.2	172,896	138,136	+ 25.2	7.6	7.4
Northwest Energy	214,900	169,100	+ 27.1	7,800	2,500	+212.0	998,000	788,700	+ 26.5	36,800	19,400	+ 89.7	3.7	2.5
Oklahoma Nat. Gas	138,779	116,170	+ 19.5	3,797	6,275	- 39.5	687,974	631,912	+ 8.9	31,196	39,275	- 20.6	4.5	6.2
Pacific Lighting	527,073	423,336	+ 24.5	27,301	18,536	+ 47.3	2,016,462	1,688,065	+ 19.5	99,004	78,098	+ 26.8	4.9	4.6
Panhandle Eastern	466,607	328,386	+ 42.1	39,209	19,456	+101.5								
Peoples Gas							2,441,556	1,879,288	+ 29.9	140,288	130,363	+ 7.6	5.7	6.9
Pioneer Corp.	206,083	160,980	+ 36.5	20,134	8,540	+135.8	660,266	555,302	+ 18.9	53,295	37,181	+ 43.3	8.1	6.7
Southern Nat. Res.	350,735	241,938	+ 45.0	26,007	23,835	+ 9.1	1,367,032	1,047,522	+ 30.5	108,782	106,072	+ 2.6	8.0	10.1
Southern Union Co.	169,998	118,561	+ 43.4	4,065	437	+830.2	672,704	533,547	+ 26.1	26,338	20,052	+ 31.4	3.9	3.8
Texas Eastern Corp.	723,927	470,196	+ 54.0	39,027	24,919	+ 56.6	2,649,222	1,965,274	+ 34.8	165,324	130,158	+ 27.0	6.2	6.6
Texas Gas Trans.	401,177	282,682	+ 41.9	17,295	11,192	+ 54.5	1,532,142	1,152,475	+ 32.9	69,314	59,191	+ 17.1	4.5	5.1
TransCanada PipeLines	583,301	507,842	+ 14.9	21,826	21,642	+ 0.9	2,370,930	2,109,657	+ 12.4	80,200	83,395	- 3.8	3.4	4.0
Transco Companies	373,701	233,253	+ 60.2	14,428	13,777	+ 4.7	1,366,612	898,086	+ 52.2	59,242	51,571	+ 14.9	4.3	5.7
Union Gas Ltd.	103,801	89,917	+ 15.4	2,117	1,587	+ 33.4	244,669[3]	207,554[3]	+ 17.9	6,105[3]	6,959[3]	- 12.3	2.5	3.4
United Energy Res.	843,514	525,092	+ 60.6	33,691	22,506	+ 49.7	2,691,805	1,913,149	+ 40.7	100,260	80,703	+ 24.2	3.7	4.2
Westcoast Trans.							722,800[1]	583,300[1]	+ 23.9	36,900[1]	33,600[1]	+ 9.8	5.1	5.8
TOTALS	8,578,017	6,132,103	+ 39.9	333,871	229,687	+ 45.4	37,654,178	29,874,024	+ 26.0	2,067,945	1,819,230	+ 13.7	5.5	6.1

**Excluding non-recurring items. *Earnings available to common stock. ‡Earnings*/Revenues ratio. ()Loss. [1]Nine months. [2]Ends July 31. [3]Six months.

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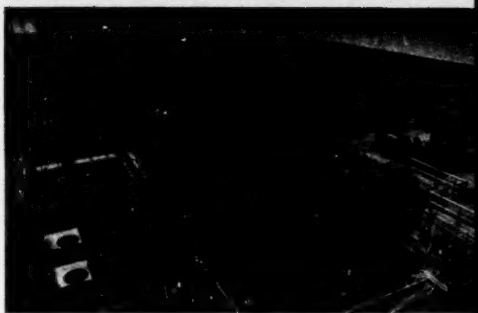

THIRD QUARTER OIL COMPANIES FINANCIAL REPORTS

	Three months ending September 30**								Twelve months ending September 30**							
	Revenues ($000)			Earnings* ($000)			Profit Margin‡		Revenues ($000)			Earnings* ($000)			Profit Margin‡	
Company	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978
Adams Res. & Energy	50,900	25,034	+103.3	1,174	1,011	+16.1	2.3	4.0	94,123[1]	44,649	+110.6	1,759[1]	1,114[1]	+57.9	1.9	2.5
Adobe Oil	25,230	17,994	+40.2	3,037	1,962	+54.8	12.0	10.9	63,460	52,624	+20.6	7,709	5,626	+37.0	12.1	10.7
Amarex Inc.[3]	3,975	2,819	+41.0	1,020	948	+7.6	25.7	33.6								
Amerada Hess	1,572,393	1,133,588	+38.7	119,196	30,561	+290.0	7.6	2.7	4,689,476	3,524,693	+33.0	350,254	97,348	+259.8	7.5	2.8
American Petrofina	427,817	299,643	+42.8	37,883	4,905	+672.3	8.9	1.6	1,129,678	845,178	+33.7	65,480	11,960	+447.5	5.8	1.4
American Quasar	8,140	6,405	+27.1	1,047	940	+11.4	12.9	14.7	21,956	19,487	+12.7	1,528	3,538	-56.8	7.0	18.2
Arapaho Petroleum	1,021	608	+67.9	35	(13)	+369.2	3.4	none	3,352	5,077	-34.0	187	65	+187.7	5.6	1.3
Argonaut Energy	615	353	+74.2	(53)	(82)		none	none	1,254	863	+45.3	(40)	(28)		none	none
Argo Petroleum	2,131	1,774	+20.1	94	(76)	+223.7	4.4	none	6,093	5,128	+18.8	229	(337)	+168.0	3.8	none
Asamera Oil	64,627	41,887	+54.3	3,439	1,027	+234.9	5.3	2.5	119,041[1]	83,409[1]	+42.7	6,610[1]	1,583[1]	+317.6	5.6	1.9
#Ashland Oil	1,966,342	1,509,837	+30.2	63,429	64,766	-2.1	3.2	4.3	5,255,452	4,116,547	+27.7	127,939	111,096	+15.2	2.4	2.7
#Atlantic Richfield	4,378,657	3,408,006	+28.5	320,363	220,524	+45.3	7.3	6.5	11,627,060	9,168,738	+22.8	822,936	581,751	+41.5	7.1	6.1
Beard Oil	3,536	2,265	+56.1	618	598	+3.3	17.5	26.4	8,730	6,548	+33.3	1,039	1,575	-34.0	11.9	24.1
Belco Petroleum	185,807	112,278	+65.5	22,930	11,289	+103.1	12.3	10.1	441,057	323,640	+36.3	54,136	34,870	+55.3	12.3	10.8
Brock Exploration	1,176	751	+56.6	231	119	+94.1	19.6	15.8	2,190	1,486	+47.4	468	463	+1.1	21.4	31.2
Buttes Gas & Oil	30,539	45,962	-33.6	151	244	-38.1	0.5	0.5	102,824	120,475	-14.7	1,134	492	+130.5	1.1	0.4
C&K Petroleum	8,178	5,571	+46.8	1,142	533	+114.3	14.0	9.6	21,315	15,608	+36.6	1,842	1,232	+49.5	8.6	7.9
Callon Petroleum[4]	1,704	1,302	+30.9	373	318	+17.3	21.9	24.4								
Cities Service	1,601,600	1,124,000	+42.5	86,100	52,600	+63.7	5.4	4.7	4,472,500	3,431,500	+30.3	241,300	148,300	+62.7	5.4	4.3
Clark O&R	311,995	264,825	+17.8	13,433	4,506	+198.1	4.3	1.7	854,095	715,019	+19.5	29,555	5,762	+412.9	3.5	0.8
Commonwealth OR	332,200	246,000	+35.0	23,200	2,000	+1060.0	7.0	0.8	889,300	695,800	+27.8	71,300	(2,600)	+2842.3	8.0	none
Consolidated O&G	4,953	3,265	+51.7	1,049	(2,636)	+139.8	21.2	none	24,152	19,036	+26.9	665	(345)	+292.8	3.5	none
#Conoco Inc.	3,448,700	2,450,700	+40.7	247,100	105,800	+133.6	7.1	4.4	9,287,000	7,042,100	+31.9	624,700	296,000	+111.0	6.7	4.2
Crestmont O&G	2,810	1,443	+94.7	982	356	+175.8	34.9	24.7	6,155	4,897	+25.7	2,004	1,070	+87.3	32.6	21.9
Crown Central	283,175	156,996	+80.4	22,947	6,968	+229.3	8.1	4.4	730,773	451,257	+61.9	52,233	6,990	+647.3	7.1	1.5
Crystal Oil	46,099	26,141	+76.3	3,158	(623)	+606.9	6.9	none	111,313	75,090	+48.2	6,737	(1,970)	+442.0	6.1	none
Delhi International	5,025	4,221	+19.0	965	634	+52.2	19.2	15.0	12,275	8,415	+45.9	1,945	1,259	+54.5	15.8	15.0
Diamond Shamrock	617,629	465,330	+32.7	37,122	29,592	+25.4	6.0	6.4	1,713,209	1,361,977	+25.8	119,6[illegible]6	92,954	+28.7	7.0	6.8
Dorchester Gas[4]	125,399	72,572	+72.8	10,320	7,354	+40.3	8.2	10.1	368,267[2]	185,241[2]	+98.8	25,516[2]	15,031[2]	+69.8	6.9	8.1
Dyco Petroleum	6,822	3,395	+100.9	1,431	1,092	+31.0	21.0	32.2	15,835	8,392	+88.7	3,681	2,501	+47.2	23.2	29.8
Earth Resources[4]	137,747	105,277	+30.8	6,514	4,511	+44.4	4.7	4.3	313,405	291,885	+7.4	13,211	8,610	+53.4	4.2	2.9
Energy Minerals	2,650	1,509	+75.6	834	613	+36.1	31.5	40.6	6,158	4,808	+28.1	1,324	1,371	-3.4	21.5	28.5
Energy Reserves Gp.	28,005	18,878	+48.3	1,520	(719)	+111.4	5.4	none	68,600	55,545	+23.5	307	1,054	-70.9	0.4	1.9
Equity Oil	2,982	3,327	-10.4	850	700	+21.4	28.5	21.0	8,433	8,846	-4.7	2,018	1,978	+2.0	23.9	22.4
Exeter Oil	632	416	+51.9	268	88	+204.5	42.4	21.2	1,474	1,199	+22.9	410	224	+83.0	27.8	18.7
#Exxon	20,649,000	15,914,000	+29.8	1,145,000	525,000	+118.1	5.5	3.3	59,055,000	46,698,000	+26.5	2,930,000	1,910,000	+53.4	5.0	4.1
Felmont	10,834	8,111	+33.6	2,252	1,486	+51.5	20.8	18.3	30,021	24,235	+23.9	6,524	4,769	+36.8	21.7	19.7
Forest Oil	17,328	15,268	+13.5	1,898	1,351	+40.5	11.0	8.8	31,365	32,590	-3.8	4,873	6,646	-26.7	15.5	20.4
Galaxy Oil[4]	1,903	1,442	+32.0	(50)	81	-61.8	none	5.6								
General American	51,632	34,192	+51.0	11,735	6,617	+77.3	22.7	19.4	135,613	104,257	+30.1	30,964	19,123	+61.9	22.8	18.3
#Getty	1,329,297	926,442	+43.5	173,877	95,869	+81.4			3,574,213	2,724,933	+31.2	421,033	227,672	+84.9	11.8	8.4
Great Basins[3]	7,616	5,664	+34.5	155	592	-73.8	2.0	10.5	26,042[2]	20,661[2]	+26.0	1,589[2]	2,489[2]	-36.2	6.1	12.0
Gulf Energy & Devel.	14,780	4,538	+225.7	1,387	415	+234.2	9.4	9.1	29,863	14,169	+110.8	3,119	1,638	+90.4	10.4	11.6
#Gulf Oil	6,736,000	5,048,000	+33.4	416,000	211,000	+97.2	6.2	4.2	18,410,000	14,648,000	+25.7	956,000	548,000	+74.5	5.2	3.7
Hadson Ohio	1,949	1,120	+74.0	581	157	+270.1	29.8	14.0	4,509	3,557	+26.8	797	994	-19.8	17.7	27.9
Hamilton Brothers	33,461	28,001	+19.5	8,188	2,787	+194.1	24.5	10.0	91,520	51,865	+76.5	13,529	7,350	+83.8	14.8	14.2
Helmerich & Payne	41,833	35,573	+17.6	8,864	6,839	+29.6	21.2	19.2	116,741	95,555		24,963	19,954			
Hershey Oil	627	522	+20.1	23	(26)	+188.5	3.7	none	1,462	1,287	+13.6	(234)	(207)		none	none
Holly Corp.[3]	79,388	63,343	+25.3	1,527	2,104	-27.4	1.9	3.3	198,148	159,781	+24.0	4,806	5,277	-8.9	2.4	3.3
Houston O&M	91,112	76,457	+19.2	14,111	13,143	+7.4	15.5	17.2	249,108	242,916	+2.5	39,577	44,537	-11.1	15.9	18.3
Howell Corp.	119,546	58,078	+105.8	10,318	855	+1106.8	8.6	1.5	242,568	152,190	+59.4	20,212	2,148	+841.1	8.3	1.4
Husky Oil									672,700	524,800	+28.2	42,500	39,100	+8.7	6.3	7.5
Inexco Oil	27,583	17,361	+58.9	4,534	2,038	+122.5	16.4	11.7	73,329	55,513	+32.1	12,132	8,123	+49.4	16.5	14.6
Juniper Petroleum	4,473	2,421	+84.8	543	19	+2757.9	12.1	0.8	11,164	8,045	+38.8	747	112	+567.0	6.7	1.4
KRM Petroleum	927	443	+109.3	306	1	+30400.0	33.0	0.2	1,986	1,213	+63.7	380	(8)	+4850.0	19.1	none
Kerr-McGee Corp.	679,798	523,574	+29.8	42,592	34,179	+24.6	6.3	6.5	1,927,999	1,528,901	+26.1	119,621	78,173	+53.0	6.2	5.1
Lear Petroleum									78,314[2]	57,653[2]	+35.8	5,007[2]	3,247[2]	+54.2	6.4	5.6
Louisiana L&E	203,055	139,263	+45.8	37,691	23,074	+63.3	18.6	16.6	570,662	404,815	+41.0	124,751	72,573	+71.9	21.9	17.9
Mapco	210,508	95,572	+120.3	16,539	4,705	+251.5	7.9	4.9	552,354	402,637	+37.2	47,862	38,813	+23.3	8.7	9.6
#Marathon	1,913,635	1,199,374	+59.6	79,656	50,491	+57.8	4.2	3.4	4,979,235	3,582,550	+39.0	268,961	151,302	+77.8	5.4	4.2
May Petroleum	3,549	1,502	+136.3	147	73	+101.4	4.1	4.9	10,545	5,557	+89.8	999	627	+59.3	9.5	11.3
Maynard Oil[4]	4,296	4,137	+3.8	321	334	-3.9	7.5	8.1								
McCulloch Oil	29,930	24,146	+24.0	14,883	677	+2098.4	49.6	2.8	77,404	67,219	+15.2	16,124	4,498	+258.5	20.8	6.7
McFarland Energy	2,533	1,471	+72.2	781	295	+164.7	30.8	20.1	6,128	4,618	+32.7	1,755	897	+95.7	28.6	19.4
McMoRan Oil & Gas	7,581	4,766	+59.1	876	536	+63.4	11.6	11.2								
Mesa Petroleum	69,250	39,232	+76.5	12,172	8,383	+45.2	17.6	21.4	181,921	120,863	+50.5	37,843	30,242	+25.1	20.8	25.0
Mitchell Energy[3]	101,930	64,520	+58.0	11,411	8,716	+30.9	11.2	13.5	187,419[1]	127,303[1]	+47.2	20,022[1]	17,473[1]	+14.6	10.7	13.7
#Mobil Corp.	12,383,016	9,107,008	+36.0	594,098	258,276	+130.0	4.8	2.8	33,451,158	26,649,764	+25.5	1,435,542	792,315	+81.2	4.3	3.0
Murphy Oil	452,235	311,821	+45.0	28,625	10,949	+161.4	6.3	3.5	1,179,021	914,191	+29.0	63,960	29,207	+119.0	5.4	3.2
Natomas	254,707	236,139	+7.9	32,671	18,679	+74.9	12.8	7.9	708,403	642,384	+10.3	75,129	52,708	+42.5	10.6	8.2
Noble Affiliates	54,736	46,209	+18.5	9,156	7,176	+27.6	16.7	15.5	151,896	129,016	+17.7	22,128	19,210	+15.2	14.6	14.9
Occidental Petr.	2,608,000	1,682,000	+55.1	186,100	19,300	+864.2	7.1	1.1	6,688,200	4,489,500	+49.0	374,800	(16,600)	+2357.8	5.6	none
Ocean Oil & Gas	15,519	8,316	+86.6	2,856	1,167	+144.7	18.4	14.0	39,562	22,383	+76.8	5,824	2,019	+188.5	14.7	9.0
Oxoco	3,276	926	+253.8	106	161	-34.2	3.2	17.4	7,814	2,230	+250.4	369	174	+112.1	4.7	7.8
Pacific Resources	158,178	124,747	+26.8	3,554	2,739	+29.8	2.2	2.2	381,753	338,524	+12.8	8,717	6,423	+35.7	2.3	1.9
Patrick Petroleum[3]	8,411	5,428	+55.0	(691)	(403)		none	none	39,622[2]	20,572[2]	+92.6	1,695[2]	1,095[2]	+54.8	4.3	5.3
Pennzoil Co.	521,966	392,768	+32.9	61,164	30,725	+99.1	11.7	7.8	1,448,629	1,105,402	+31.0	165,360	85,067	+94.4	11.4	7.7
Petroleum Development	2,160	4,273	-49.4	306	568	-46.1			6,506	9,339	-30.3	717	1,516	-71.2	11.0	16.2
Petro-Lewis Corp.	23,050	11,317	+103.7	4,455	1,256	+254.7	19.3	11.1								
Phillips Petr.	2,496,015	1,751,131	+42.5	193,027	118,797	+62.5	7.7	6.8	6,699,96[illegible]	5,221,940	+28.3	584,630	438,579	+33.3	8.7	8.4
Quaker State	175,056	139,880	+25.1	7,950	6,972	+14.0	4.5	5.0	513,147	382,757	+34.1	29,057	18,571	+56.5	5.7	4.9
Reserve O&G	621,704	431,418		8,427	6,165				1,617,286	1,178,460		28,618	14,[illegible]88			
Sabine Corp.	23,052	13,190	+74.8	3,383	1,935	+74.8	14.7	14.7	58,611	40,722	+43.9	6,403	5,875	+9.0	10.9	14.4
Shell Oil	3,765,966	2,852,960	+32.0	293,335	248,873	+17.9	7.8	8.7	10,244,886	8,199,398	+24.9	794,366	621,330	+27.8	7.8	7.6
Southland Royalty	67,552	44,466	+51.9	15,883	10,077	+57.6	23.5	22.7	180,381	138,181	+30.5	37,790	32,527	+16.2	21.0	23.5
#Standard Cal.	8,144,000	6,019,000	+35.3	576,000	274,000	+110.2	7.1	4.6	22,023,000	17,762,000	+24.0	1,335,000	773,000	+72.7	6.1	4.4
#Standard Indiana	5,127,900	4,177,400	+22.8	433,800	292,000	+48.6	8.5	7.0	14,145,000	12,051,000	+17.4	1,184,100	859,700	+37.7	8.4	7.1
Standard Ohio	2,097,800	1,298,000	+61.6	366,200	125,700	+191.3	17.5	9.7	5,566,300	3,657,300	+52.2	735,100	285,700	+157.3	13.2	7.8
Summit Energy[3]									4,067[2]	3,912[2]	+4.0	1,704[2]	1,939[2]	-12.1	41.9	49.6
Sun Co.	2,611,000	1,898,000	+37.6	174,300	105,400	+65.4	6.7	5.6	7,494,000	5,478,000	+36.8	453,100	290,800	+55.8	6.0	5.3
Sundance Oil	4,052	3,941	+2.8	(1,897)	856	-121.6	none	21.7	15,309	11,532	+32.8	(2,359)	1,126	-109.5	none	9.8
Superior Oil	302,559	197,199	+53.4	63,688	24,900	+155.8	21.0	12.6	778,828	515,031	+51.2	152,605	70,349	+116.9	19.6	13.7
Supron Energy	12,000	8,433	+42.3	3,385	2,199	+53.9	28.2	26.1	34,089	26,020	+31.0	9,658	7,345	+31.5	28.3	28.2
Tenneco	2,806,000	2,113,000	+37.8	132,000	103,000	+28.2	4.7	4.9	7,989,000	6,305,000	+26.7	411,000	331,000	+24.2	5.1	5.2
Texaco Inc.	10,251,000	7,042,000	+45.6	508,983	197,086	+158.3	5.0	2.8	27,143,000	20,860,000	+30.1	1,149,562	524,200	+119.3	4.2	2.5
#Texas American	30,967	22,936	+35.0	602	602		1.9	2.6	80,293	63,780	+25.9	2,285	2,464	-7.3	2.8	3.9
Texas Oil & Gas[4]	256,425	176,070	+45.6	28,173	19,985	+41.0	11.0	11.4	899,497[2]	712,293[2]	+26.3	97,277[2]	76,534[2]	+27.1	10.8	10.7
Tipperary Corp.	19,152	13,013	+47.2	1,605	(460)	+448.9	8.4	none	47,336	35,956	+31.6	3,484	1,335	+161.0	7.4	3.7
Tosco Corp.	574,142	315,445	+82.0	23,359	11,116	+110.0	4.1	3.7	1,373,052	847,672	+62.0	53,472	9,411	+468.2	3.9	1.1
Total Petr. N.A.	251,600	159,916	+57.3	9,124	4,469	+104.2	3.6	2.8	631,042	396,815	+59.0	18,445	7,911	+133.2	2.9	2.0
Transcontinental Oil	15,879	18,051	-12.0	(1,035)	1,197	-186.5	none	6.6	45,902	43,930	+4.5	(3,536)	3,347	-205.6	none	7.6
Triton Oil & Gas[4]	3,168	3,694	-14.2	73	179	-59.2	2.3	4.8								
#Union California	2,143,866	1,635,465	+31.1	105,953	92,605	+14.4	4.9	5.7	5,771,624	4,714,508	+22.4	348,299	258,545	+37.4	6.0	5.5
United Refining	138,962	91,826	+51.3	6,305	2,337	+169.8	4.5	2.5	352,568	265,966	+32.6	13,009	5,133	+153.4	3.7	1.9
Universal Resources[3]	6,163	5,326	+15.7	603	731	+82.5	9.8	13.7	17,581	15,791	+11.3	1,833	2,922	-39.2	10.4	18.5
Wainoco Oil	5,984	4,259	+40.5	941	1,250	-24.7	15.7	29.3	16,324	11,735	+39.1	3,349	2,865	+16.9	20.5	24.4
Webb Resources	2,564	2,401	+6.8	105	284	-63.0	4.1	11.8								
Westcoast Petr.	7,798	5,745	+35.7	2,118	1,639	+29.2	27.2	28.5	22,939	16,450	+39.4	5,850	5,575	+4.9	25.5	33.9
Wichita Industries	1,743	1,191	+46.3	379	232	+63.4	21.7	19.5	4,094	3,124	+31.0	571	334	+56.0	12.7	10.7
Williams Companies	442,183	351,813	+25.7	11,868	1,803	+558.2	2.7	0.5	1,389,913	1,156,330	+20.2	46,027	28,250	+62.9	3.3	2.4
Woods Petroleum	11,042	9,378	+17.7	3,553	2,887	+23.1	32.2	30.8	31,321	28,224	+11.0	9,653	9,401	+2.7	30.8	33.3
Worldwide Energy	9,111	2,004	+354.6	904	270	+234.8	9.9	13.5	24,384	6,184	+294.3	1,299	890	+46.0	5.3	14.4
TOTALS	107,048,174	78,642,408	+36.1	6,947,714	3,563,880	+94.9	6.5	4.5	293,314,637	229,334,201	+27.9	17,662,010	10,340,416	+68.9	6.0	4.5

**Excluding non-recurring items. *Earnings available to common stock. ‡Earnings*/Revenues ratio. ()Loss. #Revenues include excise taxes. [1] Six months. [2] Twelve months. [3] Period ends July 31. [4] Period ends August 31.

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Vigorous Construction Year To Begin 1980's Decade

by **Dean Hale**, *Editor*

Pipeline projects planned, proposed, or underway in the United States now total 29,607 miles, according to PIPELINE & GAS JOURNAL's annual U.S. Pipeline Construction Survey, and 7268 miles of cross-country pipelines are expected to be installed during 1980 as mainlines and gathering systems.

The U.S. plus Canada total for planned, proposed, or underway projects is 40,451 miles. Projected miles of pipe to be installed in Canada are approximately 4000 miles of mainline and gathering lines (see related article this issue).

Altogether, that's over 11,000 miles of pipeline construction to be undertaken in the U.S. and Canada in the first year of the new decade, and a healthy boost for the economy in both nations as well as providing needed additions to transport new energy supplies.

In the U.S., of the overall total, 14,399 miles are natural gas transmission lines, 5075 are crude oil pipelines, 3168 are products pipelines, and 7965 miles are slurry pipeline projects.

Biggest news to the cross-country oil and gas pipeline business as the 1980's begin is that Canada's National Energy Board has approved new exports of 3.75 trillion cu ft of natural gas by 1987, an action that will permit pre-building of various U.S. and southern Canadian sections of the Alaska Highway Gas Pipeline Project and related lines.

NEB's approved quantities were higher than the two trillion cu ft that Canada had declared surplus in February 1979, but they are much lower than the 8.8 Tcf over 15 years that had been sought by 10 exporters and their U.S. customers.

Of the total approved, Pan-Alberta Gas Ltd. of Calgary will get 1.8 Tcf for sale to Northwest Alaskan Pipeline Co. The gas is to flow south through pre-build sections of the giant Alaskan gas project. NEB said initial flow should begin in November 1980 on the western leg of the pipeline and additional gas through an eastern leg in November 1981.

No construction is underway on either section and target dates might be impossible to achieve because regulatory proceedings haven't been completed in either Canada or in the U.S. Project sponsors in mid-1979 were planning on 280 miles of 36-in. in Canada and 160 miles of 36-in. loop on the Pacific Gas Transmission Co. system as pre-build for the western leg, and 395 miles of 42-in. in Canada and 809 miles of 42-in. (Northern Border Pipeline) in the U.S. for the eastern leg.

Outlook for pipeline construction in the United States is for 3260 miles of gas transmission pipelines, 1121 miles of crude oil pipelines, 1047 miles of products pipelines, and 1840 miles of crude and gas gathering lines.

Gas Pipelines

Big news, of course, is that work will finally get underway on some segments of the long-planned Alaska Highway Gas Pipeline Project, principally in the pre-build sections of the western and eastern legs. Pacific Gas Transmission's plan is to install 160 miles of 36-in. in various loops on its system to increase gas flow capacity. Another 480 miles of 36-in. would remain to be installed later to provide a second 36-in. line from the Canadian border to the Oregon-California border. Pacific Gas & Electric's section of the western leg include 290 miles of 36-in. to be installed later.

1980 PIPELINE OUTLOOK

Miles Planned, Pipeline Projects

Type of Line	U.S.	Canada
Natural Gas	14,399	8,810
Crude Oil	5,075	1,434
Products	3,168	600
Slurry	7,965	—
TOTALS	29,607	10,844
GRAND TOTAL, U.S. and Canada		40,451

Projected 1980 Completion, Miles

Type of Line	U.S.	Canada
Natural Gas	3,760	
Crude Oil	1,121	
Products	1,047	4,000
Slurry	—	
Oil/Gas Gathering	1,840	
	7,268	4,000
GRAND TOTAL		11,268

Pacific Gas Transmission has another major gas supply project in the works – 695 miles of 20-, 30-, and 36-in. line from the Green River Basin of Wyoming to California, with the line route crossing Utah into Nevada and on into southeastern California.

Final arrangements on the $500-million Trailblazer Pipeline System to move gas from the Rock Springs area of Wyoming and Utah to western, midwestern, and eastern markets have been made by the four interstate gas transmission firms who will participate in the system. Mountain Fuel Supply Co. will build and operate the 88-mile, 30-in. Overthrust Pipeline section in western Wyoming. Colorado Interstate will build and operate a 264-mile, 36-in. section from Rock Springs to south of Cheyenne. The eastern section, Trailblazer Pipeline Co. will be owned jointly by an affiliate of Natural Gas Pipeline Co. of America (Peoples Gas of Chicago) and Columbia Gulf Transmission Co. The 445-mile, 36-in. section will be built and operated by NGPLA.

United Gas Pipe Line Co. is extending its system to the Panhandle area of Texas and a connection with Colorado Interstate Gas Co.'s system in the Hugoton-Panhandle Field that could eventually lead to interconnections and transportation of Rocky Mountain natural gas to Louisiana. United's proposal is for a 635-mile, 30-in. line from Moore County, Tex. across Oklahoma and southwest Arkansas to near West Monroe, La. The $386 million would initially have five compressor stations.

Northern Natural Gas is getting deeper into Texas with plans to build a 160-mile, 12-in. or larger gas pipeline in southwestern Texas at a cost of $35 million.

In the northeastern U.S., Algonquin Gas Transmission Co. and Transcontinental Gas Pipe Line Corp. propose to take gas from Q&M Pipelines Ltd. at the New Brunswick-Maine border and transport it south to as far as Rhode Island, beginning in 1983. Plan is based on proposals by Q&M and Pan-Alberta Gas Ltd. to transport gas from eastern Quebec to the Maritime Provinces and to export up to 250 MMcf per day to U.S. markets.

Northern border Pipeline Co., the eastern leg of the Alaska Highway Gas Pipeline Project, is likely to get construction underway on some sections of its 809-mile, 42-in. line into Ventura, Iowa pending final FERC approvals, pipe deliveries, and closing out any possible ROW problems.

Hearings continued in December on the Ozark Gas Pipeline project to build 445 miles of 4 to 20-in. pipelines in Oklahoma and Arkansas and provide a new outlet for gas from the Anadarko Basin.

United Texas Gas Transmission Co., an affiliate of United Gas Pipeline, has under construction 284 miles of 30-in. in south Texas, between Katy and Laredo.

Mountain Fuel Supply Co., expanding its system to acquire new gas supplies, plans 300 miles of 1- thru 8-in. laterals in Utah and Wyoming.

With the American Natural Resources coal gasification plant in North Dakota, Great Lakes Gas Transmission Co.'s proposed 365-mile, 30-in. line from Mercer County, N. Dak. to Thief River Falls, Minn. gains new life. Line will not be required until plant is operational, but work on design and engineering is expected to be renewed.

Carbon Dioxide Pipelines

Four proposals involving the transportation of carbon dioxide from areas where it can be recovered to areas where it can be used in enhanced oil recovery projects are also in the news. One line, 72 miles of 6- and 8-in. by Transpetco., is currently before the FERC. Line would be built in the Texas Panhandle, originating near Borger.

Atlantic Richfield Co. still has under study a 375-mile, 20-in. line from the Raton Basin of Colorado to near Yoakum, Texas.

Shell Oil's Cortez Pipeline Co. also has plans for a major 16- or 20-in. CO_2 line from near Cortez, Colo. to West Texas. And in Mississippi, Shell Pipe Line Co. is working on plans for a 90-mile, 20-in. CO_2 line.

Other projects reportedly are in the mill as producers look for new ways to increase production from existing oil fields, especially those where surplus carbon dioxide from other areas can be put to good use stimulating oil recovery.

Crude Oil Pipelines

Northern Tier Pipeline Co. has passed all of the tests so far in its quest for authority to begin construction on its 1557 mile, 40- and 42-in. oil pipeline designed to transport Alaskan and other imported crude oil from the Pacific Coast to Midwestern refineries and markets. Fate of the line is now in the hands of President Carter, who is expected to give the project a green light.

The line did receive a mixed approval from former interior secretary Andrus, who suggested the pipeline company should arrange all of its financing within one year – but also suggested that the line make extensive changes in its westernmost route near Seattle and also find another terminal site.

Northern Pipeline Co. (of Delaware) has yet to get its project moving in efforts to build a 480-mile, 24-in. line to transport crude oil from Wood River, Ill. to St. Paul, Minn. Right-of-way acquisitions have been a large stumbling block for the line.

Other major crude oil projects on the books include a 204-mile, 16-in. line from Kingman to a proposed refinery at Mobil, Ariz. at a cost of $38 million; Sioux Pipeline Co., which plans a 160-mile, 10-in. line linking St. Paul, Minn. and Superior, Wis., and Northville Industries, which plans 174 miles of 30-in. between Texas City, Tex. and Nederland, Tex.

Products Pipelines

Colonial Pipeline Co., whose 1979 program included 230 miles of 36- and 40-in. parallel line adjacent to its mainline and 100 miles of 16-in. lateral between Atlanta and Chattanooga, has another major segment in the works for 1980. New construction will involve 150 miles of 36-in. between Richmond, Va. and the Baltimore, Md. area.

Barbour Energy reportedly is studying plans for 390 miles of 20-in. to link Brownsville, Tex. to Houston.

Hydrocarbon Transportation Inc. is working on 240 miles of 10-in. line to move natural gas liquids from Buston, Kan. to Plattsburg, Mo.

Mapco, Tulsa-based pipeline transporter of NGL, is expected to expand westward with a 700-mile, 10-in. system from Kutz, N. Mex. to Wyoming and Utah producing areas and NGL extraction plants.

Biggest project lying in the wings is the 890-mile, 24-in. Transgulf Pipeline project involving conversion of an existing natural gas line to products transportation. The 24-in. line would be abandoned by Florida Gas Transmission Co. so conversion could be attained.

Slurry Pipelines

There are eight projects involving 7965 miles of pipeline in the slurry pipeline category – all designed to move coal in slurry form from mostly western mining areas to electric generating plant sites across the country stretching from the Pacific Northwest to Florida. Project closest to getting underway is Energy Transportation Systems, Inc., with rights to go ahead with R-O-W acquisition in most of its territory.

Even though the current Congress has not made a favorable move to provide right of *eminent domain* to the slurry pipelines, the companies involved are confident that it will be eventually granted, and continue to work on firming up their project designs. **P&GJ**

Planned And Proposed Pipeline Projects

U.S.—Natural Gas Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Alabama-Tennessee Natural Gas Co	17.7	8	Lamar Co., Miss.		3.5	Approved	
	11	12	Colbert Co., Ala.		1.7	Before FERC	
Ammonia Enterprises Pipe Line Inc	52	10	Onshore-offshore La			Before FERC	
Arkansas-Louisiana Gas Co	28.4	various	Arkoma Basin, Okla., gathering			Awaits start	
	17.5	16	Chiles Dome Field, Okla.			Bids out	
	16.7	30	Northwest Ark			Planned	
Atlantic Richfield Co	375	20	Raton Basin, Colo.	Yoakum, Tex. (CO_2 line)		Under study	
Big Three Industries	160	12	Freeport, Tex.	Victoria, Tex.		Awaits start	
	10	12	Dickinson, Tex.			Underway	Goldrus Constr.
	6	12	Beaumont, Tex.			Underway	
	3.5	20	Bayport, Tex.			Underway	Belmont Constr. Inc
Colorado Interstate Gas Co	52	24	Green River/Rawlins, Colo., loop			Before FERC	
Columbia Gas Transmission Corp	181	16-20	Va. & W.Va.		46	Awaits bidding	
	73.8	4-24	Crawford Storage Field, Ohio, Phase II			Awaits bidding	
	41	1-24	W.Va., N.Y. & Pa., & Ohio compression		7.7	Before FERC	
	23.5	2-36	W.Va., Ohio, Pa. & Ky.			Before FERC	
	19.6	6	Kanawha Co., W.Va.			Awaits bidding	
	14.5	10	Fairfield, Hocking & Athens Cos., Ohio			Underway	Carl E. Smith Inc
	4	30	Acadia Parish, La.		2.3	Before FERC	
Columbia Gulf Transmission Corp & Natural Gas Pipeline Co of America	127.7	10, 12, 20	Eugene Is. & W. Cameron Areas offshore La			Before FERC	
Columbia Gulf Transmission Co & Northern Natural Gas Co	25.5	16, 30	Offshore La		24	Approved	
Consumers Power Co	22	4, 6	Northern Mich			Planned	
	8	4	Southern Mich			Planned	
Cortez Pipeline Co. (Shell)	500	16 or 20	Cortez, Colo., CO_2 line to West Tex			Under study	
Delhi Gas Pipe Line Co	433	4-8	East Tex. & Gulf Coast			Planned	
	65	4-12	Okla. & Tex.			Planned	
Diamond Shamrock Corp	50	4	Tex. Panhandle gathering			Planned	
El Paso Natural Gas Co	463	30-36	Port O'Connor, Tex.	Ft. Stockton, Tex.		Before FERC	
	120	24, 30, 32	San Juan, Eddy & McKinley Cos., N.M.		69	Before FERC	
	47.7	4-16	Permian, Tex.-N.M. area			Before FERC	
	35.1	6-20	Hemphill, Tex. & Roger Mills Co., Okla.			Before FERC	
	33.9	24	Ignacio, Colo.	Toprock, Ariz.		Before FERC	
	30	4, 20	San Juan Co., N.M.			Delayed	
	27.5	4-12	Webb & Zapata cos., Tex.			Planned	
	18	6-10	Offshore Tex		14.1	Approved	
Enterprise Pipeline Co. of Texas	52	6	Garysville, La.	Grangeville, La.		Approved	
Enterprise Products Co	25	16	Houston Ship Channel	Mont Belvieu, Tex.		Bids called	
Eugene Island Pipeline System	108	20	Block 128, S. Marsh Is., offshore Tex	Caillou Is.		Planned	
Farmland Industries	100	12, 16	Pollock, La.	Humphreys, La.		Before USCE	
	50	16	Baldwin, La.	Scott, La.		Planned	
	20	12	Bay Marchand area, offshore La			Before USCE	
Farmland Industries & Louisiana Intrastate Gas Corp	51	24, 36	Humphreys, La.	Donaldsonville, La.		Planned	
Florida Gas Transmission Co	51.2	26, 30	Zachry, La.	Ft. Lauderdale, Fla.		Approved	
	41.3	2, 20	Block 665, Matagorda Is. area	Refugio Co., Tex.	24.7	Before FERC	
	23	8, 10	Block 340, Brazos area, offshore Tex.	Matagorda Co., Tex.		Planned	
	17.2	4, 20	Orlando, Fla., area			Approved	
	13	10	Block 721, Matagorda Is. area	San Patricio Co., Tex.		Planned	
	1.6	10	Block 830, Matagorda Is. area			Approved	
Great Lakes Transmission Co	365	30	Mercer Co., N.D., SNG line	Thief River Falls, Minn.		Before FERC	
	125	30, 36	Minn., Wisc. & Mich.		70.6	Before FERC	
Gulf Energy & Development Co	50	10-14	South Tex			Planned	
Kansas-Nebraska Natural Gas Co	195	4-12	Bowdoin area, Valley Co., Mont.		8.4	Awaits start	
Louisiana Resources Co	24.3	20	Cameron Parish, La.			Bidding	
	18.2	20	Cameron Parish, La.			Delayed	
Memphis Light, Gas & Water	26	6-22	Memphis area			Planned	
Mexoil Corp	25	8	La			Planned	
Michigan-Wisconsin Pipe Line Co	93	36-42	La., Miss., Tenn., Ky. & Ind. loop; Ohio & Mich. loop		78.1	Before FERC	
	66.9	6-20	Woodward-Laverne area, Okla.			Approved	
	63	12-30	Offshore Louisiana			Planned	
	27.7	30	Mich & Wisc.			Before FERC	
	12	42	Mich., Ind. & Ill. loop		15.9	Before FERC	
	6.5	42	Joliet, Ill., area loop		6.1	Before FERC	
Montana Fuel Supply Co	35	10	Converse Co., Wyo.	Douglas, Wyo.		Before FERC	
Montana Power Co	16	6	Leroy Field, Mont.			Planned	
Mountain Fuel Supply Co	300	1-8	Utah & Wyo.		23.7	Before FERC	
National Fuel Gas Supply Corp. & Natural Gas Storage Corp	22	4-12, 16-36	Ellisburg, Pa.			Planned	
Natural Gas Pipeline Co of America	27.5	30	Ingleside, Tex.	Sinton, Tex.		Before FERC	
	27	8	Bryan-Marshall Cos.	Love Co., Okla.	2.7	Before FERC	
	8	16, 20	High Is. area, offshore Tex			Underway	
Natural Gas Pipeline Co of America, Colorado Interstate Gas Co., Columbia Gulf Transmission Co., Mountain Fuel Supply Co (Trailblazer System)	797	30, 36	Rock Springs, Wyo.	Beatrice, Neb.	400	Before FERC	
Northern Border Pipeline Co	809	42	Near Monchy, Sask.	Ventura, Iowa		Before FERC	Williams Bros
Northern Natural Gas Co	160	12	Batesville, Tex.	Eldorado, Tex.	35	Before FERC	
	50	12	Eddy Co., N.M.	Hobbs, N.M.	13	Before FERC	
	42	24	Block 686, Matagorda Is. area	Refugio Co., Tex.	80	Before FERC	
Northwest Alaska Pipeline Corp	739	48	Prudhoe Bay	Alaska-Yukon border	5000	Before FERC	
Northwest Pipeline Corp	359	30	Wash. & Ore.			Before FERC	
	358	24, 30	Stanfield, Ore.	Twin Falls, Idaho		Before FERC	
	82	4-12	Moxa Arch area, Wyo.			Before FERC	
	49	10, 16, 20	Uinta Co., Wyo.			Before FERC	
	43	20	Ore. & Idaho loops			Before FERC	
Nueces Co.	28	4, 6	Kit Carson & Bent Cos., Colo. to Colorado Interstate System			Before FERC	
Oklahoma Natural Gas Co	98	2-30	Okla. projects			Planned	
Ozark Gas Pipeline Corp	445	20, 4-10	Pittsburg Co., Okla. mainline & gathering to White Co., Ark.		104	Before FERC	
Pacific Gas & Electric Co	290	36	Malin, Ore.	Brentwood, Calif.		Planned	
	40	30	Searchlight, Nev.	Southeast Calif.		Under study	
Pacific Gas Transmission Co	695	20, 30, 36	Green River Basin, Wyo., to Southeastern Calif.		341	Before FERC	

U.S.—Natural Gas Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Pacific Gas Transmission Co.	592	36	Kingsgate, B.C.	Malin, Ore.		Partial approval	
Panhandle Eastern Pipeline Co.	32	8-10	Major Co., Okla.		4.9	Before FERC	
	23	16	Kingfisher Co., Okla., Sooner System		10.1	Underway	Cap-Con Internat'l
	21	4-10	Woods & Woodward cos., Okla.		6.1	Before FERC	
Seagull Pipeline Corp.	14	8	Brazos area, offshore Tex. to Sargent, Tex.		4	Planned	
Shell Pipe Line Co.	90	20	Rankin Co., Miss.	Lincoln Co., Miss.		Planned—CO_2 line	
Southern California LNG Terminal Co.	63	32	Ventura Co., Calif.			Before FERC	
Southern Natural Gas Co.	48	12	Heflin, Ala.	Chattanooga, Tenn.		Before FERC	
	31	20	Thomaston, Ga.	Griffin, Ga.		Before FERC	
	24	6-20	Bienville Parish, La.			Underway	
	20.7	18	South Atlanta, Ga.	Thomaston, Ga.		Before FERC	
	13	12	Lake St. Catherine	Lake Ponchartrain, La.	5.2	Before FERC	
Southern Natural Gas Co. & Tennessee Gas Pipeline Co.	8.4	24	Bear Creek & Ysclosky areas, La.			Awaits start	
Southern Union Co.	11	16	Albuquerque	Sandoval & Bernalillo cos., N.M.		Planned	
	2	6	Amoco Nellis line, N.M. to Lea Co., N.M.			Planned	
	2	4	Lea Co., N.M.			Planned	
Southwest Gas Storage Co. & Panhandle Eastern Pipeline Co.	30	various	Borchers North Field, Meade Co., Kans.		72.9	Before FERC	
Sterling Pipeline Co.	60	12-16	Okla. transmission & gathering			Awaits start	
	100	N/A	Lee & Fayette cos., Tex.			Underway	H&K Constr.
Sun Pipeline Co.	6	6	Velma, Okla.	Duncan, Okla.		Planned	
Tejas Gas Corp.	32	8	West Texas			Planned	
Tejas Gas Corp. & Coronado Transmission Corp.	22	8	Zapata Co., Tex.			Planned	
Tenneco Inc.	450	26	St. Johns, N.B.	Nassau, N.Y.		Planned	
	82	14, 18, 24	Baton Rouge, La.	Ft. Lauderdale, Fla.		Before FERC	
Tennessee Gas Pipeline Co.	30	30	Block 493, W. Cameron area, offshore La.	Block 227, E. Cameron area	40.5	Before FERC	
	22	36	Ruston, La.			Underway	Gregory & Cook
	6	8	Block 116A, S. Marsh Is. area	Block 108, S. Marsh Is. area	3.6	Before FERC	
Tennessee Gas Pipeline Co. & Columbia Gulf Transmission Co.	26	26, 36	South Pass area, offshore La.		48.8	Before FERC	
Texas Eastern Gas Pipeline Co.	12	12	Block 384, Eugene Is. area			Planned	
	10	12	Block A568, High Is. area, offshore Tex.	Block A540		Planned	
Texas Gas Transmission Co.	7	4	Terrebonne Parish, La.			Before USCE	
	15	12	Jefferson Davis Parish, La.			Planned	
Texas Sea Rim Pipeline Inc.	14	14	Sabine Pass Area, offshore Tex.			Before FERC	
Transcontinental Gas Pipeline Corp.	33.7	4-12	Onshore La. & Tex.		7.4	Before FERC	
	27	12	Block A7, Matagorda Is. Area, offshore Tex.	Block A620	13.2	Before FERC	
	19	16	Block 131, Galveston Area, offshore Tex.	Block A531, High Is. Area		Before FERC	
	18.5	4-12	W. Cameron Area, South Addition		4.1	Before FERC	
	17	20	Block 498, W. Cameron	Block A264, HIOS		Before FERC	
	14	24	Sabine River, La., loop			Before FERC	
	13	36	Calcasieu Parish, La., lateral		10.4	Before FERC	Ford, Bacon & Davis
	13	20	Block A85, Mustang Is. Area, offshore Tex.	Block A133, Brazos Area		Planned	
	7.5	8-12	High Is. Area, East Addition		2.4	Before FERC	
	5.4	16	Block 120K, Ship Shoal Area, offshore La.	Block 137	3.3	Before FERC	
	4.8	6, 8	Block 34, West Delta Area, offshore La.	Blocks 31 & 32	3	Before FERC	
	3	16	Block A548, High Is. Area	Block A546, HIOS		Planned	
	2.8	8	Block 185A-B, S. Timbalier Area, offshore La.		2.3	Before FERC	
	2	12	Block A467, High Is. Area			Planned	
	2	12	Block 310B, Vermilion Area to Block 313		2.6	Before FERC	
	1	16	Block 494, W. Cameron Area	Block 498		Planned	
	1	12	Block A492, High Is. Area			Planned	
Transcontinental Gas Pipeline Corp. & Algonquin Gas Transmission Corp.	350	N/A	Near Calais, Me.	Burrillville, R.I.	420	Planned	
Transco, Columbia Gulf, Northern Natural & Texas Gas Transmission Co.	31	12, 16, 20	High Is. & Galveston areas, offshore Tex.		32	Approved by FERC	
Transok Pipeline Co.	63	24	Dustin, Okla.	Tulsa		Underway	Great Plains Constr.
Transpetco	72	6, 8	Borger, Tex. area	(CO_2 line)		Before FERC	Eagleton Engineering
Transwestern Pipeline Co.	60	6-10	Tex. & N.M.			Planned	McVean & Barlow; Flint
Trunkline Gas Co.	22	24	La.			Before USCE	
	30	30	Lake Charles, La.			Underway	Banister Pipelines America
TXO Gathering Co.	16	N/A	Colo., Okla. & Tex.			Planned	
United Gas Pipeline Co.	21.5	30	Erath, La.	Weeks Is. Junc., La.	12.7	Await start	
	13	20	Livingston, Tex.			Underway	Gregory & Cook
	2	10	Terrebonne Parish, La.			Before USCE	
	635	30	West Monroe Junc., La. to Texas Panhandle		386	Before FERC	
United Texas Gas Transmission Co.	284	30	Katy, Tex.	Laredo, Tex.	110	Underway	Curran Houston Inc.
Western LNG Terminal	286	42, 48	Point Conception, Calif.			Before FERC	
Western Slope Gas Co.	200	6, 10, 12	Colo.			Planned	
	20	12	Colo.			Await start	

U.S.—Crude Oil Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
ARCO Pipeline Co.	32	36	Texas City, Tex.	Houston		Bids out	
Ashland Pipeline Co.	14	20	Catlettsburg, Ky.	Ironton, Ill.		Planned	
Chevron	5	18	San Pueblo, Calif.	Richmond, Calif.		Designing	
Continental Oil Co.	20	10	Cameron Area, offshore La.			Before FERC	
DEEPORT	31	36	Harbor Is. Bay, Tex.	Corpus Christi	500	Proposed	
Department of Energy	57	36	Weeks Is., La.	St. James, La.	27.8	Underway	Parsons-Gilbane, Banister
	49	36	Bayou Chocktaw salt dome	St. James, La.		Underway	Houston
	42	24	Kleer Mine Storage	Texoma, Tex.		Approved	

U.S.—Crude Oil Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
	25	36	W Hackberry La storage dome	Block 42 W Cameron area offshore La		Awaits bidding	
	14	16	Eastern Ky strategic storage			Proposed	
	13	20	Southern Ohio strategic storage			Proposed	
Exxon U S A	8	6, 10, 16	Corpus Christi area			Planned	
	4.8	6, 8, 12	Hondo Platform, Santa Barbara Channel	SALM area		Awaits start	Alaska Constructors
Gulf Oil Corp	61	8, 16	Iberia, Vermilion & Cameron areas, offshore La			Before USCE	
	37	6, 12, 16	Grand Is. & S. Timbalier areas, offshore La			Planned	
	32	12	Cameron Area, offshore La			Approved	
	27	12, 20	Terrebonne & Lafourche parishes, offshore La			Before USCE	
	24	14, 16	Block 33 Cameron Area to Block 235			Approved	
Koch Exploration Co	16	6	St Bernard & Orleans parishes, La			Before USCE	
Locap Pipeline (Shell et al)	55	48	Phase I – Clovelly Storage Terminal La	St James La	100	Approved	
	44	24	Phase I – Clovelly Storage Terminal La	Norco La		Planned	
Loop Inc	1.5	56	Phase II – SPM's	Pump platform		Proposed	
	21	48	Phase II – Pump platform	Beach		Proposed	
	29	48	Phase II – Beach	Clovelly storage area		Proposed	
	3.4	56	Phase III – SPM's	Pump platform		Proposed	
	21	48	Phase III – Pump platform	Beach		Proposed	
	29	48	Phase III – Beach	Clovelly storage area		Proposed	
Marathon Pipe Line Co	20.7	24, 30	St James & St John the Baptist parishes, La			Underway	H C Price Co
New England Energy Co	35	24	Portland, Me	Sanford, Me		Planned	
Northern Pipe Line Co of Delaware	490	24	Wood River, Ill	Pine Bend, Minn		Planned	
Northern Tier Pipeline Co	1557	40, 42	Port Angeles, Wash	Clearbrook, Minn	1400	Engineering	Butler, Williams Bros
Northville Industries Inc	174	30	Texas City, Tex	Houston-Freeport-Nederland		Before USCE	
	18 (dual)	N/A	Pelican Is., offshore Tex	Texas City, Tex		Before USCE	
Phillips Pipeline Co	20	10	San Bernard, Tex			Planned	
Provident Energy Co	204	16	Kingman, Ariz	Mobil, Ariz., refinery (proposed)	38	Planned	
Santa Fe Energy Co	24	24	Trinity Co., Tex			Engineering	
Shell Oil Co	41	6, 8	Vermilion & S Marsh Is. areas			Before USCE	
	28	12	Block 128, Mississippi Canyon, offshore La			Planned	
	20	12	W Delta & Grand Is. areas			Before USCE	
	16	16	Long Beach Harbor	Platform Ellen, San Pedro, Calif		Underway	Alaska Constructors
	9	8	Block 311, Mississippi Canyon, offshore La			Planned	
	5	42	Long Beach, Calif	Wilmington, Calif		Underway	Hood Corp
	2	16	Long Beach	San Pedro Bay		Planned	
Sioux Pipeline Co	160	10	Superior, Wisc	St Paul, Minn		Planned	
Southern Union Refining Co	47	8	Midland, Tex	Lovington, N M		Engineering	International Pipeline Engrs
Southwestern Gas Pipeline Co	27	12	Millsap, Tex	Morgan Mill, Tex		Planned	Morgan Constr. Co
Texaco Inc	21	6, 8	Port Arthur, Tex			Planned	
Texas Deepwater Port Authority	26 (dual)	52	Offshore Freeport, Tex	to shore		Approved	
U S Navy	135	30	Naval Petroleum Reserve	Redland, Calif		Approved	Pipe Line Tech
	47	4-24	San Joaquin Valley, Calif			Underway	Granite Constr. Co
Wallace & Wallace Chemical & Oil Co	214	22-30	Mobile, Ala	Tuskegee, Ala		Planned	Ford, Bacon & Davis
Williams Pipe Line Co	112	18	Des Moines, Iowa	Clear Lake, Minn	25	Planned	
Williams Pipe Line Co	163	12	Minneapolis/St Paul	Lake Superior Refineries		Under Study	
	691	24	Cushing Okla	Mason City, Iowa		Under Study	

U.S.—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Barbour Energy Co., Inc	390	20	Brownsville, Tex	Houston		Under study	Ford, Bacon & Davis
Calnev Pipeline Co	54	6	George AFB, Calif	Edwards AFB, Calif		Planned	
Chase Pipeline Co	190	12	Scott City, Kans	Wichita		Underway	Great Plains Constr
Colonial Pipeline Co	150	36	Richmond, Va	Baltimore, MD		Planned	
Enterprise Products Co	55	6	Jay, Fla	Ala -Miss. border		Planned	
Exxon Pipeline Co	15	6	Baton Rouge area			Planned	
	11	8	Baton Rouge area			Planned	
Getty Pipeline Inc	25	16	Delaware City, Del	Marcus Hook, Pa	10	Delayed for EIS	Worthy Bros
Hydrocarbon Transportation Inc	240	10	Bushton, Kans	Plattsburg, Mo	30	Approved	
Loop Inc	21	4	Onshore Lafourche Parish, La	Pump platform		Approved	
Mapco Inc	700	10	Kutz, N M	Wyo.-Utah	80	Planned	
Shell Oil Co	254	12	Napoleonville, La	Mt Belvieu, Tex	50	Underway	
	32	4	Payner, Tex	Eustace, Tex		Planned	
	19	4-6	Norco, La	Avondale, La		Planned	
	3	6	Geismar, La			Planned	
Shell Pipe Line Corp	28	10	Norco, La	Sorrento, La		Planned	
Transgulf Pipeline Co	800	24	Baton Rouge, La	Ft Lauderdale, Fla	125	Planned – conversion from gas to products	
Southern Pacific Pipeline, Inc	36	24	Norwalk, Calif	Colton, Calif		Planned	
Union Carbide Corp	13	6	Napoleonville, La., area			Planned	
U S Navy	8	10	Point Loma, San Diego Bay	North Is. Nav. Air Sta		Underway	Hood Corp
Williams Pipe Line Co	691	24	Cushing, Okla	Mason City, Iowa		Under study	

U.S.—Slurry Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLIONS)	STATUS	CONTRACTOR OR ENGINEERING CO.
Boeing Engineering & Construction Co	645	N/A	Utah	Calif		Planned	
ETSI	1380	38	Northeastern Wyo	Baton Rouge		Planned	
Florida Gas Co	1500	28-48	Eastern Ky./W Va	Ga. & Fla		Planned	
Houston Natural Gas Co	900	18	Colo.-N M border	Texas Gulf		Planned	
Nevada Power Co	180	22	Las Vegas	Alton, Utah		Planned	
Northwest Pipeline Corp & Gulf Interstate Engineering	1100	N/A	Northeastern Wyo	Ore.-Wash. border		Proposed	
Tesoro Petroleum Corp	1000	N/A	Ky	Southeastern States		Under study	Fluor Corp.; Dames & Moore
Texas Eastern Transmission Corp & Brown & Root Inc	1260	36-40	Mont	Texas Gulf		Under study	

Construction Forecast

Canada Expects 4000-Mile Year in 1980

by L. O. Rowland, *Canadian Editor*

Big-inch pipeline construction in Canada will begin to pull out of its multi-year slump in 1980 *if* the Federal Government moves quickly to implement whatever recommendation for additional gas export was expected to be contained in the National Energy Board report on a group of applications for a total of more than 1 billion cu ft per day for a short term.

Favorable, early treatment of the Pan-Alberta Gas Group and Progas applications can result in the start of prebuilding of gas transmission line facilities which will ultimately be shared with Alaska gas as integral parts of the Northwest-Foothills project. Although the 1980 program, as drafted tentatively pending the NEB decision (which was expected late in November), amounts to only about 135 miles of 36-inch pipe, it will be followed up in 1981 by more than 400 miles of 36-, 42- and possibly some of the 56-in. pipe.

The 1980 plans involve what will, in effect, be loops of part of the exisitng Alberta Gas Trunk Line and Alberta Natural Gas systems to carry gas for California through what will eventually become the western leg of the Northwest-Foothills line. The 1981 construction will be lines required to carry Canadian gas into the Northern Border system for delivery east, and will include an across-Alberta line and a connecting transverse line through southwestern Saskatchewan. This ultimately will become part of the eastern leg of Northwest-Foothills.

Apart from these prospects, the immediate outlook for

CANADA—Natural Gas Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	COST ($MILLION)	STATUS	CONTRACTOR OR ENGINEERING CO.
Alberta Natural Gas Ltd.	300	Var	Gas gathering laterals in Alberta			Planned	
Esso Resources Canada Ltd.	290	10	Fort MacMurray, Alta	Judy Creek, Alta		Planned	(CO_2 line)
	60	6					
Foothills Pipeline Ltd.	2032	42/48/56	Alaska-Yukon border	Alberta-U.S. border	4300	Awaiting NEB Approval	
Foothills Pipeline Ltd.	740	34	Near Whitehorse	Mackenzie Delta area	2500	Planned	(Dempster lateral)
Polar Gas Project	2338	36/42	Melville Island	Longlac, Ontario		Planned	
Q&M Pipelines Ltd.	1140	4 to 30	Quebec	Nova Scotia		Planned	
Shell Canada Resources Ltd.	32	14	Ram River	Limestone Field		Planned	
Shell Canada Resources Ltd.	80	12-24	Northeast British Columbia lateras			Planned	
TransCanada PipeLines Ltd.	30	36	Maple, Ontario	Lisgar, Ontario		Planned	
TransCanada PipeLines Ltd.	1012	12 to 30	Quebec and Maritime Provinces (GAS EAST project)			Planned	
TransCanada PipeLines Ltd.	25	6	Thorn, Ontario	Menascaming, Quebec		Planned	
TransCanada PipeLines Ltd.	125	24	Sable Island	Canso, Nova Scotia		Planned	
Westcoast Transmission Co. Ltd.	506	2/4/8/16	British Columbia mainland to Vancouver Island		280	Planned	
Westcoast Transmission Co. Ltd.	100	36	Loops on main line in British Columbia			Planned	

CANADA—Products Pipelines

Amoco Canada Petroleum Co. Ltd.	500	12	Sarnia, Ontario	Quebec City, Quebec	Planned
Pan Canadian Petroleum Co. Ltd.	100	10	LPG Line		Planned

CANADA—Crude Oil Pipelines

Esso Resources Canada Ltd. (Interprovincial Pipeline Ltd.)	560	12	Norman Wells, Northwest Territories to Zama, Alberta		Planned
Husky Oil Co.	600	2 to 12	Oil gathering system in Alberta and Saskatchewan		Planned
Murphy Oil Co. Ltd.	28	10	Unity, Saskatchewan area		Planned
Peace Pipe Line Ltd.	146	12	Fox Creek, Alta	Grande Prairie, Alta	Planned
Peace Pipe Line Ltd.	100	10	Oil Line		Planned

——Jerry Lozynsky, Marine Pipeline

Westcoast Transmission Co., Ltd.'s 36-in. crossed rugged terrain.

1980 will be enhanced by the catalytic effect on related lines that will have to be built to connect new gas reserves tied into the export approvals. There is no reliable figure for total volume, but a reasonable assumption is that up to 300 miles of laterals will be built by Alberta Gas Trunk Line and others in relation to the western leg.

Westcoast Transmission Co., Ltd. has tentative plans to go ahead with its deferred program of looping out all the remaining gaps in its main line loop, of which only about 100 miles remain to be filled-in to provide two complete lines from the Taylor gas plant to Huntingdon, B.C. The loop will be done with 36-in. pipe, but the extent to which this can be done in 1980 depends on somewhat unpredictable reaction of the National Energy Board as to the imminence of this requirement. It will be needed in any case by 1981 because of indicated growth of the American market, now being served, but which has been subject to cutbacks in the past three winters when gas was in short supply.

Westcoast has a firm program of winter construction of about 80 miles of lateral gas gathering main lines in northeastern British Columbia for completion in the spring. These are large diameters for gathering lines from 12- to 24-in. Shell Canada has awarded the contract for its main insulated sour gas line from Limestone Field to the Aquitaine Ram River gas processing plant, in the southern Alberta foothills; project consists of 32 miles of 14-in. with unusual specifications of 0.514-in. wall thickness and 2600 psig operating pressure – making an interesting technical construction job. Completion is set for early summer.

Because of the extreme concern over possible interruption to crude oil imports in the eastern provinces, there is increasing possiblity of a start on the Q&M/Gas East project to move gas east of Montreal. The merger of the competing plans of Q&M Pipelines, a subsidiary of Alberta Gas Trunk Line, and TransCanada PipeLines during the National Energy Board hearing has cleared the way for an early decision if the NEB shares the feeling of urgency expressed by the Quebec and Maritime Provinces premiers. Construction at least as far a Quebec City is possible, involving as much as 200 miles of 30- or 24-in. pipe. TCPL also has a proposal before the NEB to loop about 31 miles of its main line north of Toronto with 36-inch pipe next summer.

Among possible small-inch projects for 1980 are two proposals to move crude oil and LPG from the Deep Basin west and north of Grande Prairie in northwestern Alberta to the Peace Pipe Line terminal at Valleyview and the Peace terminal at Simonette respectively. One is by Pan-Canadian Petroleum, the other by Peace Pipe Line, and each would involve about 100 miles of 10-in. pipe.

A number of other LPG and gas laterals in the planning stage, and those that should be required to bring on new fields to replace declining productivity in others could bring the total of small-inch mainline construction to about 1200 miles.

Field gathering systems offer a sustained volume of activity. There are more than 10,000 shut-in gas wells in Alberta and 1000 or more could be required for the new export market if the full volume in the application is granted. This would provide a basic requirement for 1000 miles of gathering lines, in addition to the normal minimum of about 1000 miles that has been the standard for the past several years to maintain producibility in older fields and attach new fields being placed under sales contracts.

The internal buoyancy in Alberta from industrial development and population growth has kept up a rate of increase in gas demand not shared by the rest of Canada. In addition the substantial rise in oil well completions in both Alberta and Saskatchewan, with instant sales available, will provide a significant volume of perhaps 500 miles of oil gathering lines in 1980.

Water injection schemes and a moderate amount of gas utility distribution mains will probably add some 300 miles. Altogether, the categories of gathering, injection, and distribution lines for the year should provide upwards of 2800 miles. Taking the whole range, construction volume could reach 4300 miles or better, for an increase of about 50% over the low cyclical year 1978.

Two substantial small-inch projects not likely to be approved in time for 1980 completion, but possibly could be at least past the application stage before year's end, are the Esso Resources' Norman Wells oil pipeline and the Esso Resources carbon dioxide pipeline.

The Norman Wells proposal involves 560 miles of 12-in. pipe from Norman Wells Field in the Northwest Territories, up the Mackenzie Valley, and terminating at Zama in northern Alberta where it would connect with existing Alberta systems. It is designed to handle 25,000 bbl per day from this 58-year-old field, which has become economic for sale outside its locality only because of the high oil price. In case of a real squeeze on international supply, it is possible it might be expedited through the hearing process but unlikely to be completed before the summer of 1981 because it involves a great deal of winter muskeg terrain that is not economically accessible in summer.

The CO_2 project is a 350-mile line, including 290 miles of 10-in. and 60 miles of 6-in. pipe, which would carry CO_2 from the two Fort McMurray oil sands plants and the Esso fertilizer plant at Redwater to Esso's Judy Creek oil field for a miscible enhanced recovery scheme. The complexity of CO_2 recovery facilities and the groundwork for the miscible flood are such that completion before 1981 is very unlikely – but it could easily reach the tender call stage late in 1980. **P&GJ**

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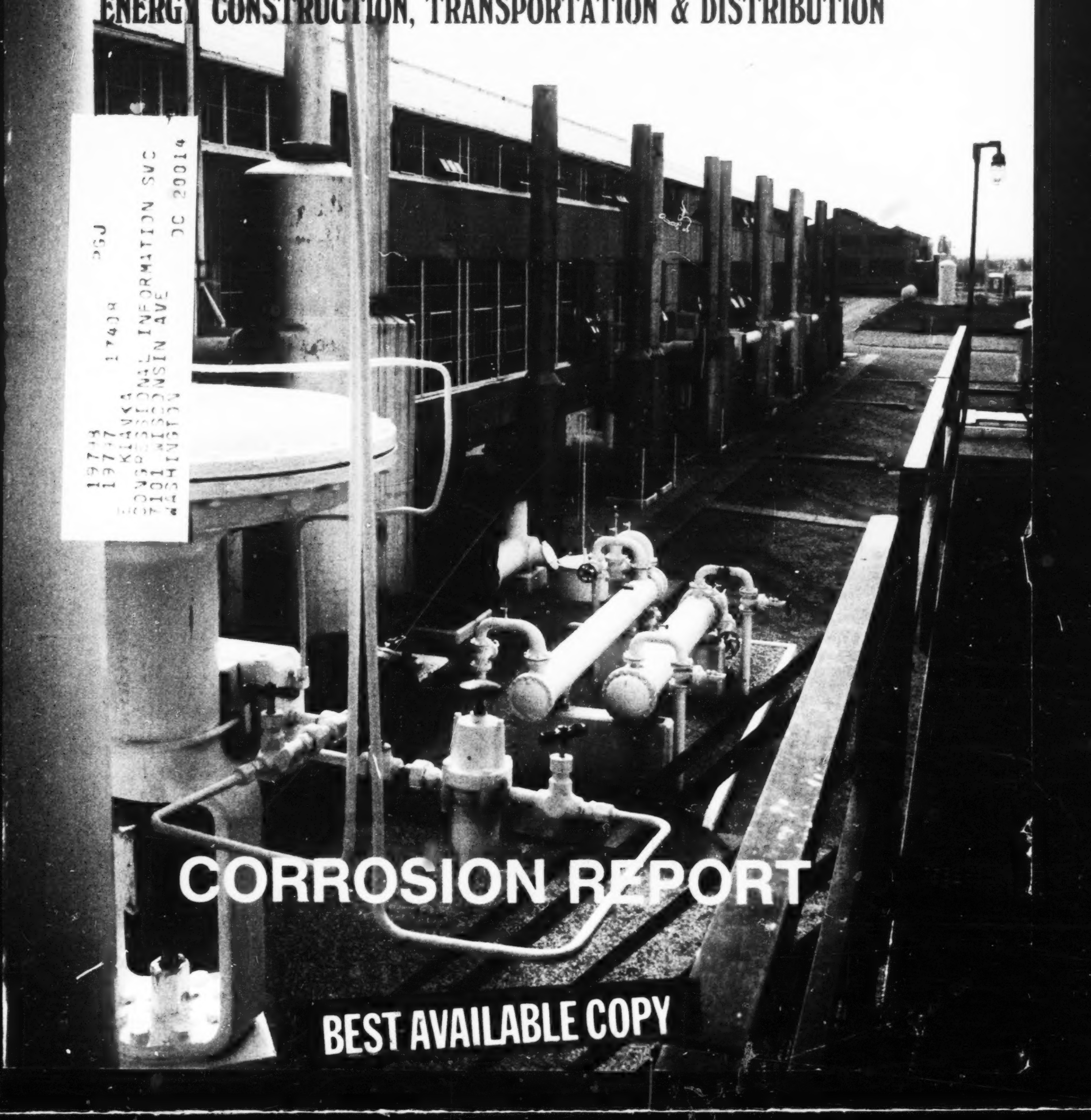

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Giant Oil/Gas Fields: Tomorrow's Hope ... 21

During 1968-1978, 290 giant oil and gas fields were discovered around the world; they supply much of the petroleum energy now used internationally. For the future, says renowned geologist and independent producer Mike Halbouty, it is logical to assume that there are many other undiscovered giants waiting to be found, many of them offshore — and they will all need pipelines to move that energy to market.

How To Make Over-The-Line Surveys 26

Pros and cons of over-the-line surveys have been discussed and argued for many years — author does not debate the issue, but instead gives inside information on how to make such surveys, what equipment to use, methodology that can help, and some caveats of interest.

Abandoned, Corroded Line Rehabilitated .. 34

When Wheeling Pittsburgh Steel found it needed nitrogen at one plant, and had surplus nitrogen at another plant 15 miles away, a pipeline seemed the logical answer. Even better than having to install a new line, the firm found it had available an abandoned 15-mile, 10-in. coke oven gas line. The corroded line was cleaned and rehabilitated by a Pittsburgh firm specializing in such projects.

How Paving Affects Pipe-To-Soil Potentials.................. 42

Effectiveness of cathodic protection of buried pipelines is monitored by accurate pipe-to-soil measurements — but such measurements of lines under paving aren't always accurate. Recent study reveals how various instruments perform, suggests ways to get better results.

5000 Miles of ROW For Sale 58

Important rights-of-way in the Northeast and Midwest, suitable and desirable for pipeline use, are now available for sale from the Penn Central Corp. — ROW acquired from predecessor companies of the Penn Central Transportation Co., once the nation's largest railroad.

How Archeology Affects Pipeline Route Selection 60

State, local, and federal regulations frequently require pipeline operators and builders to make an archaeological survey along the pipeline route before the digging begins; it's all an effort to preserve the valuable, buried origins of man's society. Here are details on why it is important. It is also the law.

THE COVER

A maze of piping, exhaust stacks and mufflers, valves, and other essential equipment typifies a modern compressor station operated by a leading gas transmission company.

— Courtesy Panhandle Eastern Pipe Line Co.

First Base For Exploration –

Because oil companies have the heavy responsibility of seeking oil supplies, their first job is acquiring leases or concessions on land or offshore that have oil and natural gas potential.

Our table gives developed and undeveloped leases for 146 U.S. investor-owned oil/gas companies. Acreage is for 1978 as shown in most annual reports or provided by the companies.

U.S. acreage under lease is approximately 240 million acres for the 146 companies shown. This is only about 10% of the total 2.3 billion acres of the United States, including Alaska (375 million acres) as well as the other 49 states.

Independent Petroleum Association of America estimates all domestic acreage under lease for oil/gas exploration is 432 million acres – 19% of U.S. land available for lease. (Federal government owns 760.4 million acres – 33% of all U.S. lands.)

This is the most acreage under lease since 1959 when leaseholdings were about 424 million acres.

Decline in leaseholdings in the years since 1959 parallels decline in drilling brought on by wellhead price controls and increasing federal intervention in the energy business.

Now that price controls are being relaxed – if not dropped – the U.S. active rig count (2577 active rigs in December 1979) is higher than it's been in 20 years. And oil firms are leasing more acreage for prospecting.

It's getting harder to get leases on U.S. lands. There are many bills introduced to Congress each year to set aside more areas to be restricted "wilderness" – especially in Alaska. Already more than 19 million acres are part of the National Wilderness System – and are not available for any development.

Leaseholdings are getting more expensive, too. According to *Forbes*, lease prices/acre in Oklahoma have gone to $275/acre from $65/acre in 1976. Louisiana Gulf Coast acreages cost $100/acre, up from $25/acre in 1976.

ACREAGE LEASED FOR

	Company	Developed Net Acreage Year ended 12/31/78		Undeveloped Net Acreage Year ended 12/31/78		*Reserves in million bbl net oil equivalent 12/31/78
		U.S.	Total	U.S.	Total	
1.	Adams Resources & Energy	8,480	8,480	43,219	43,219	2
2.	Adobe Oil	57,531	58,135	1,079,367	1,198,928	37
3.	Altex Oil	38,935	38,935	210,033	210,033	1*
4.	Amarex Inc.	48,627	48,627	95,686	95,686	15
5.	Amcole Energy	6,490	6,490	7,393	7,393	6
6.	Amerada Hess	320,000	1,287,000	2,323,000	29,348,000	929
7.	American Natural Resources	55,735	77,715	1,493,468	1,645,215	53
8.	American Petrofina	210,276	210,276	568,028	568,028	69
9.	American Quasar Petroleum	15,118	34,154	1,393,005	1,730,260	35
10.	Aminoil (RJ Reynolds)	98,867	143,773	705,282	1,220,445	300
11.	Apache Corp.	15,608	15,608	196,700	196,700	17
12.	Arapaho Petroleum	11,02[illegible]	11,084	91,743	101,973	11
13.	Argonaut Energy	35,604	35,604	45,784	45,784	3
14.	Argo Petroleum	9,765	11,571	58,701	87,160	16
15.	Ashland Oil	820,000	969,000	1,736,000	5,820,000	266
16.	Asamera	18,996	28,359	286,728	4,164,102	34
17.	Atlantic Richfield	1,252,000	1,896,000	5,267,000	32,736,000	5,405
18.	Basic Resources Corp.	0	23,157	0	1,546	
19.	Beard Oil	18,715	18,715	2,103,135	2,103,135	4
20.	Belco Petroleum	214,000	257,000	186,000	1,167,000	249
21.	Brock Exploration	4,629	6,452	10,815	10,815	2
22.	R.L. Burns Corp.	36,903	36,903			7
23.	Buttes Gas & Oil	37,157	121,338	262,144	9,434,810	34
24.	C&K Petroleum	30,579	30,579	233,000	459,824	14
25.	Centura Petroleum	6,491	6,491	11,908	11,908	1
26.	Champlin (Union Pacific)	314,500	347,000	1,133,678	1,246,921	323
27.	Cities Service	1,700,000	1,900,000	10,100,000	24,600,000	975
28.	Clark O&R	16,304	16,304	17,602	75,673	
29.	Coastal States	756,947	765,947	3,436,948	3,436,948	254
30.	Columbia Gas	1,380,965	1,388,389	4,021,956	8,163,864	2
31.	Consolidated Natural Gas	886,544	886,544	4,325,743	4,325,743	203
32.	Consolidated Oil & Gas	73,004	73,004	98,646	321,307	33
33.	Conoco Inc.	1,252,912	2,230,310	3,389,000	69,743,000	3,239
34.	Crown Central Petr.	71,772	71,772	137,562	142,356	9
35.	Crystal Oil	60,613	60,613	208,961	208,961	17
36.	Delhi International	663	39,237	13,190	25,638,223	136
37.	Diamond Shamrock	521,029	521,029	2,502,190	2,502,190	192
38.	Dorchester Gas	291,645	302,207	137,563	921,715	72
39.	Dyco Petroleum	24,600	29,600	146,200	146,840	6
40.	Echo Oil	5,096	5,096	61,479	61,479	1
41.	El Paso Co.	953,298	953,298	1,326,067	1,500,702	1,059
42.	Energy Minerals Corp.	20,707	20,707	128,155	128,155	4
43.	Energy Reserves Group	321,307	321,307	1,339,145	4,874,726	69
44.	Energy Sources	2,087	4,122	5,555	25,355	1
45.	Enserch Corp.	387,497	389,293	1,153,344	1,718,270	56
46.	Equity Oil	10,155	14,004	415,930	439,204	12
47.	Exeter Oil	1,064	1,064	0	0	21
48.	Exxon	4,332,000	19,850,000	11,306,000	203,394,000	28,212
49.	Felmont Oil	64,921	65,898	159,063	208,937	14
50.	Florida Exploration	10,653	10,653	94,553	94,553	13
51.	Forest Oil	104,290	110,307	346,365	752,564	73
52.	Galaxy Oil	20,515	20,515	74,765	74,765	6
53.	General American Oil	225,000	277,000	821,000	1,384,000	168
54.	Getty Oil	929,000	1,010,000	4,749,000	21,784,000	2,714
55.	W.R. Grace	185,930	197,787	652,802	1,012,562	137
56.	Great Basins	12,094	90,919	478,949	897,225	46
57.	Gulf Energy & Development	9,006	9,006	25,099	25,099	2
58.	Gulf Oil Co.	1,876,000	4,220,000	12,785,000	43,240,000	3,323
59.	Hadson Ohio	10,919	10,919	70,215	70,215	3
60.	Hamilton Brothers Petr.	32,763	78,516	92,017	1,522,970	49
61.	Helmerich & Payne	99,056	.99,056	144,339	144,339	53
62.	Helmet Petroleum	3,397	3,456	28,312	38,542	1
63.	Holly Corp.	23,771	23,771	234,619	234,619	4
64.	Houston Natural Gas	328,654	328,654	948,104	948,104	75
65.	Houston Oil & Minerals	74,752	74,752	777,241	777,241	131
66.	Husky Oil Ltd.	68,000	298,000	973,000	3,362,000	184
67.	Inexco Oil	142,551	142,551	950,716	964,716	42
68.	Juniper Petroleum	31,288	36,015	640,965	926,933	7
69.	Kansas Nebraska Nat. Gas	337,402	337,402	3,296,074	3,296,074	152
70.	Kerr-McGee Corp.	293,726	488,196	755,360	1,665,892	288
71.	Kirby Exploration	5,245	5,317	238,134	238,134	4
72.	Louisiana Land & Explora.	125,000	162,000	1,745,000	4,876,000	274
73.	MGF Oil	9,800	9,800	275,000	275,000	4
74.	Mapco	142,298	142,816	501,154	2,703,260	82
75.	Marathon Oil	383,661	2,912,532	1,600,130	35,365,199	1,797

Acreage Under Lease

EXPLORATION/PRODUCTION

	Company	Developed Net Acreage Year ended 12/31/78 U.S.	Developed Net Acreage Year ended 12/31/78 Total	Undeveloped Net Acreage Year ended 12/31/78 U.S.	Undeveloped Net Acreage Year ended 12/31/78 Total	*Reserves in million bbl net oil equivalent 12/31/78
76.	Marion Corp	6,059	6,059	66,102	66,102	13
77.	May Petroleum	39,406	39,406	230,832	230,832	408
78.	Maynard Oil	55,139	55,139	123,628	123,628	28
79.	McCulloch Oil	49,230[1]	49,230	106,742[1]	110,143	37
80.	McFarland Energy	9,525	9,525	33,872	33,872	8
81.	McMoRan Oil & Gas	29,572	40,931	34,360	181,399	24
82.	Mesa Petroleum	276,977	490,637	992,833	2,409,761	348
83.	Mitchell Energy	443,600	443,600	1,000,100	1,000,100	145
84.	Mobil Corp.	1,965,000	3,010,000	4,980,000	55,364,000	10,225
85.	Mountain Fuel Supply	174,326	174,326	2,112,927	2,112,927	343
86.	Murphy Oil	84,000	198,000	435,000	13,267,000	392
87.	Natomas Co.	55,700	85,700[e]	387,800	15,387,000[e]	78
88.	Noble Affiliates	80,490	184,330	393,891	493,551	53
89.	North American Royalties	32,000	32,000	162,000	162,000	10
90.	Northern Natural Gas	60,000	60,000	1,715,000	1,715,000	30
91.	Northwest Energy			551,770	551,770	
92.	Occidental Petroleum	38,420	1,927,980	156,067	6,754,272	1,174
93.	Oklahoma Natural Gas	80,536	80,536	126,763	126,763	18
94.	Oxoco	8,345	8,345	20,791	9,038,812	3
95.	Panhandle Eastern	974,546	1,018,546	1,139,635	1,343,635	287
96.	Patrick Petroleum	20,940	23,196	716,974	2,942,771	14
97.	Patton Oil	4,584	4,584	53,937	53,937	
98.	Peninsula Resources	4,336	4,336	28,334	28,334	2
99.	Pennzoil Co.	828,961	883,779	2,554,475	6,158,071	322
100.	Petroleum Development	5,297	5,297	176,969	176,969	2
101.	Petro-Lewis	300,606	300,606	355,597	355,597	30
102.	Phillips Petroleum	1,250,000	1,386,000	4,563,000	71,790,000	3,140
103.	Pioneer Corp.	86,217	86,217	187,373	187,373	35
104.	Premier Resources	12,879	31,849	11,496	36,463	3
105.	Quaker State	66,413	66,413	287,343	287,343	33
106.	Reading & Bates	32,599	1,341,058	567,384	2,127,384	17[e]
107.	Reserve Oil & Gas	76,023	140,257	557,336	2,169,952	79
108.	Sabine Corp.	273,221	289,472	802,058	1,114,335	55
109.	Santa Fe International	22,409	27,675	162,216	162,216	83
110.	Seneca Oil	7,455	7,455	52,180	52,180	1[e]
111.	Shell Oil	976,000	1,028,000	12,960,000	56,019,000	2,931
112.	Southern Natural Res.	46,718	46,718	153,017	153,017	43
113.	Southern Union Co.	4,800	4,800	90,700	90,700	4
114.	Southland Royalty	656,000	656,000	2,057,000	2,057,000	299
115.	Standard California	1,461,000	2,951,000	6,401,000	137,934,000	17,163
116.	Standard Indiana	2,785,000	3,752,000	23,535,000	67,996,000	5,733
117.	Standard Ohio	219,600	219,600	335,159	335,159	98
118.	Summit Energy	8,698	8,698	4,853	4,853	6
119.	Sun Co.	1,679,000	2,085,000	2,826,000	23,867,000	1,603
120.	Sundance Oil	14,141	34,634	123,375	645,792	41
121.	Superior Oil	561,000	1,377,000	1,305,000	18,749,000	488
122.	Supron Energy	255,000	255,000	1,050,000	1,078,000	82
123.	Tejas Gas	3,305	3,305	6,389	6,389	1
124.	Tenneco	572,519	689,856	3,217,203	3,902,012	834
125.	Texaco Inc.	2,183,000	4,948,000	7,115,000	93,728,000	18,636
126.	Texas American Oil	40,289	40,289	212,816	212,816	12
127.	Texas Eastern Corp.	64,259	154,610	540,000	899,000	338
128.	Texas Gas Transmission	58,391	58,391	491,196	491,196	46
129.	Tipperary Corp.	24,284	24,284	632,752	632,752	8
130.	Tomlinson Oil	9,053	9,053	45,946	45,946	1
131.	Total Petroleum N.A.	632,507	1,483,497	0	1,992,572	80
132.	Transcontinental Oil	43,212	43,212	108,241	108,241	4
133.	Transco Companies	52,401	52,401	136,543	136,543	70
134.	TransOcean Oil	35,169	35,701	2,348,541	2,407,933	57
135.	Triton Oil & Gas	29,524	40,672	255,536	3,434,732	23
136.	Union California	1,038,000	1,411,000	3,631,000	27,125,000	1,993
137.	United Energy Resources	73,571	74,114	292,351	300,692	28
138.	Universal Resources	40,100	40,100	257,608	257,608	9
139.	Vanderbilt Energy	12,576	12,576	6,623	15,613	2
140.	Wainoco Oil	25,305	107,076	100,528	1,327,281	29
141.	Webb Resources	9,836	20,425	373,607	373,607	4
142.	Wichita Industries	4,233	4,233	522,743	522,743	1
143.	Williams Companies	16,322	16,322	1,359,549	1,359,549	36
144.	Wiser Oil	110,626	110,626	181,900	200,400	22
145.	Woods Petroleum	43,830	53,550	335,110	682,705	27
146.	Worldwide Energy	41,800	67,500	78,000	123,400	11
	TOTAL	43,591,812	81,169,858	196,207,100	1,220,238,282	120,255

*Natural gas converted to oil equivalent: 6 Mcf = 1 bbl. [1] U.S. and Canada. [e] Our estimate.

Foreign acreage under exploration contracts (for the 146) total 1162 million acres. This large sum is important because operations are not so limited abroad as they are in the U.S.

Getting a concession to drill in a foreign country is not cheap, though, and can be very complicated. To get permission to conduct seismic exploration, a company has to pay the government for the concession and come to an agreement on how many wells will be drilled over what period of time and how much money will be spent for exploration.

After all that, if the company actually finds oil or gas, it probably shares production with the owner-government. And any remaining production may eventually be nationalized by the government.

This is the first table gathered showing so many individual company holdings and this list is not exhaustive.

An investor will be wise to learn the amount of producing and undeveloped acreage any company owns before committing capital.

Oil and gas reserves for each concern (last column) are shown in million barrels of oil equivalent, a total of foreign and domestic for each concern.

There is one clear fact – a company without acreage can't move far in the business of oil/gas exploration and production.

Average acreage for the 146 companies is 1.6 million acres in the U.S. and 8.0 million acres in foreign lands.

One reason for Texas Oil & Gas Corp.'s sharp rise is that the company has increased its undeveloped acreage each year since 1971–from 153,000 net acres to 4.4 million net acres in 1978.

Those companies with more than 10 million leased acres undeveloped are Amerada Hess, Atlantic Richfield, Cities Service, Conoco, Delhi International, Exxon, Getty, Gulf, Marathon, Mobil, Murphy, Natomas, Phillips, Shell, Standard California, Standard Indiana, Sun, Superior, Texaco and Union California.

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THE COVER
LNG Aquarius docked at Semboku II terminal of Osaka Gas Company, Osaka, Japan.

— Photo courtesy General Dynamics, Quincy Shipbuilding Division.

Developments Proceed Slowly In International LNG Industry 17

More regulation of the LNG industry is promised as result of the Pipeline Safety Act of 1979 that mandates the DOT secretary to establish "minimum safety standards" for new LNG facilities in the U.S. — while LNG prices continue to escalate — and development of new LNG supplies continues to slow down. Major LNG activity appears in the making for Europe, Japan, and Southeast Asia.

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Details on LNG projects around the world are given in P&GJ's exclusive tabulation of LNG facilities in operation, under construction, or planned.

How Osaka Gas Uses LNG Cold 23

Osaka Gas Co., which will be regasifying about 6.3 million tons annually of LNG, has extensive plans to utilize the cold available in LNG that will effectively use that energy, help the company make money, and diversify the company's activities; LNG cold will be used for power recovery, ammonia synthesis, desalination, air separation, food freezing and storage, cryogenic crushing, and related operations.

Steady Growth Seen In Next Decade For World LNG Trade 39

Between now and the mid-1980's, size of world trade in LNG may well more than double — at an annual growth rate of about 16% (compared to a 23.5% annual growth rate of the past 15 years); here's complete tabulation of what to expect, what might happen.

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Dow Chemical's Midland Division uses more than 140 miles of overhead and underground piping in sizes to 36-in. to distribute utilities over a 1600-acre site.

Alaskan Gas Line Planning Team An Elite Group Of Arctic Experts 54

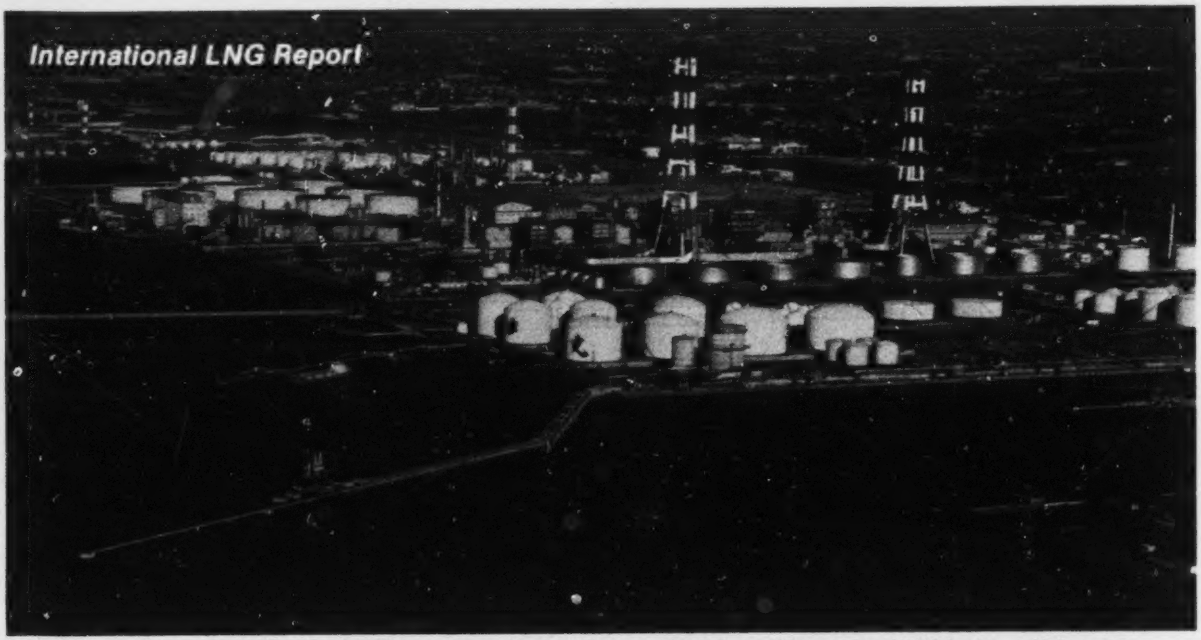
Members of the team assembled to design, build, and operate the Alaska Highway Gas Pipeline Project have more experience and Arctic working expertise than any group in North America — and they are now in the final design phases of the world's largest construction project.

Gas Pipeline Company Equipment Operators Get Hands-On Training 62

Learning by doing, rather than learning from a book, is the popular method in vocational training today — and Kansas-Nebraska Natural Gas Co. is teaching its transmission department employees to operate heavy equipment "hands on."

Intricate Connection In Charlestown 66

When Boston Gas Co. planned a repair in the Charlestown area amidst busy traffic in a street congested with other utilities, it was a project that required careful timing and carefully coordinated effort.



Semboku II Terminal at Osaka Gas Co.'s LNG import complex contributes to the volume of international LNG trade — which grows, albeit slowly, despite stringent regulatory policies, rising inflation, and burgeoning bureaucracy worldwide.

Developments Proceed Slowly In World LNG Industry

by **Dean Hale**, *Editor*

Despite considerable activity by companies and government regulatory agencies involved, little tangible progress has been seen on proposed LNG baseload projects around the world. Current operations have been characterized by their high performance, certainly, but even this has been marred in spots by shipping and operations mishaps.

U.S. Developments

On November 30, President Carter signed into law the *Pipeline Safety Act of 1979*, which amends the *Natural Gas Pipeline Safety Act of 1968* and includes regulation for LNG facilities under Title I – Natural Gas. The Act requires the Secretary of Transportation to establish minimum safety standards for siting, design, installation, construction, initial inspection, and initial testing of any new LNG facility. Contingency plans to be implemented at new facilities must also be prepared.

Facilities for which applications were filed for siting, construction, and operation at Federal, state, or local levels prior to March 1, 1978 are "grandfathered" under this legislation.

The standards will apply to replacement components for existing facilities, but only if these will render them compatible with other existing components or would not otherwise be impractical. The Secretary is also required to conduct a study of the risks involved in LNG and LPG operations and of methods for assuring adequate financial responsibility by owners and operators. The results of these studies are to be transmitted to Congress for action. The legislation represents a compromise, favorable to the industry, of Senate S.411 and House H.R. 51 – legislation passed last summer.

The Secretary of Transportation, through the Materials Transportation Bureau, has now issued *LNG Facilities: Federal Safety Standard*, under CFR Part 193 for subparts covering siting, design, and construction.

The National Fire Protection Association issued a 1979 edition of its Standard 59A (Standard for the Production, Storage, and Handling of Liquefied Natural Gas) in November. The new edition contains several significant additions in the areas of siting, design, and construction.

At the project level, the Federal Energy Regulatory Commission issued its order on rehearing of the applications to transport LNG from Alaska and Indonesia to California (Pac-Alaska and Pac-Indonesia Projects) and to build and operate a terminal at Little Cojo, near Point Conception, Calif. Subject to minor modifications and clarifications, FERC's October 12 order on the applications was reaffirmed and rehearing denied.

Petitions were filed subsequently by Bixby Ranch Co., the Holister Ranchowners' Association, and the Sierra Club with the U.S. Court of Appeals for the District of Columbia Circuit for review of the FERC orders. The Economic Regulatory Administration had completed action on its part of the regulatory procedure with its Opinion No. 8, issued on September 26. Required seismic studies at Little Cojo and related activities are underway by project partners.

LNG supertankers, such as Gotaas-Larsen, Inc.'s *Golar Freeze,* have helped worldwide LNG trade to attain remarkable annual growth.

LNG Pricing

After many months of negotiations, El Paso Natural Gas Co. agreed to modifications in the Contractual Sales Price Provisions of its October 9, 1969, contract with Sonatrach. The new provisions brought the F.O.B. pricing for the El Paso I project in line with subsequent Algerian contracts. Change was required because the original contract with a then-current F.O.B. price of about $0.37 per million Btu resulted in a negative cash flow for Sonatrach. The new (July 1979) base sales price of $1.75 per million Btu will escalate with changes in No. 6 and No. 2 fuel oils. The calculated contract sales price was discounted by $0.60/million Btu initially to decrease to zero after June 30, 1983.

ERA approved an initerim price in August for the period to December 31 for importers Columbia LNG Corp., Consolidated System LNG Co., and Southern Energy Co. On December 30, ERA approved the revised price of $1.945 per million Btu for the period January 1, 1980, to June 30, 1980, with subsequent changes as provided in the supply contract, which has another 23 years to run. Adding ocean transport and revaporization costs would bring the current price to $3.43/million Btu at the point where the fuel enters the pipeline. In its approval, ERA noted that the 1-billion-cu-ft-per-day gas supply is still cheaper than other imported gas, including that from Mexico and Canada.

The ERA conditioned its approval of the new price by requiring that this LNG supply be incrementally priced to certain industrial end-users under the provisions of Title II of the Natural Gas Policy Act (NGPA). Explaining the rationale behind its incremental pricing decision, the ERA said: "Because of the substantial increase in the price of this gas occasioned by the Amendment Agreement [between El Paso Algerian and Sonatrach], we find that continuing to roll-in the price of this gas with other pipeline supplies would result in the subsidization of this LNG import at the expense of more secure sources of domestic natural gas and would tend to delay the conversion of industrial users of natural gas to coal and other domestic alternative fuels, contrary to the long-term energy interests of the nation."

Interestingly, the Algerian Parliament has asked for an investigation of why the price was not raised prior to this.

LNG Accidents

Involved in the El Paso I project, *El Paso Paul Kaiser* ran aground while on a loaded voyage off Gibraltar on June 29. The vessel was stranded during a maneuver to avoid a fishing vessel crossing her bow. After *Kaiser* was refloated and towed to a sheltered anchorage, her sister ship, *El Paso Sonatrach,* moored alongside and the cargo of approximately 90,000 m^3 was transferred. Lightering through a single flexible hose took about 48 hours and was accomplished without difficulty. *El Paso Sonatrach* unloaded the cargo at Cove Point in July. The LNG was still well within specifications. Although extensive damage was done to the ship's structure in the grounding, no LNG was released. Repairs at Chantiers de France's Dunkerque yard, estimated to cost about $10 million, are expected to be completed in May.

With the Avondale LNG ships delayed due to problems with the insulation/secondary containment system, El Paso has been chartering Algerian flag vessels from Sonatrach and other laid-up vessels, such as Gotaas Larsen's *Golar Freeze* and the former Gazocean ship *Ben Franklin.* Reportedly it is the quantity of LNG produced at the GL1-Z plant at Bethioua, Algeria, not shipping unavailability or terminal capacity, that limits project deliveries.

On October 6, an explosion occurred at the motor control center in an electrical substation at Cove Point Terminal. The explosion resulted from natural gas that leaked into the building through electrical conduit connecting one of ten second-stage LNG pumps. No damage was done to any LNG-containing equipment and no LNG was released. Columbia LNG and federal and state agencies investigated the accident. FERC approved temporary recertification of the facility for interim repair construction. The facility was able to vaporize about 150-million-cu- ft-per-day by October 19, about 250- million-cu-ft-per-day in mid-November, and 500 million cu ft per day by the beginning of December. The 500-million-cu-ft-per-day capacity authorized by FERC enabled Cove Point to receive all of the cargo that would have been received had the accident not occurred.

New LNG Supplies

New U.S. baseload supply contracts that *were* expected to be announced in the last nine months are still pending. The Trinidad and Tobago project involving Peoples Gas and Tenneco subsidiaries for a nominal 600-million-cu-ft-per-day is still in negotiation.

Nigeria's Bonny LNG has reportedly modified its project to deliver half of the 1.6-billion-cu-ft-per-day to European rather than U.S. customers. Announcement of signed contracts by U.S. customers for their 800-million-cu-ft-per-day share is reported imminent.

European Developments

In mid-May, the Belgian government approved construction of the S.A. Distrigaz terminal at Zeebrugge. Due to delays in gaining approvals and during harbor expansion, the terminal is not expected to be completed before late 1985. Because the take-or-pay contract goes into effect with Algeria in the second half of 1982, an alternative delivery point will be required. Reportedly, this will be Gas de France's Montoir terminal, through gas delivery by displacement.

Algeria's GL2-Z liquefaction plant nears completion, its first production currently scheduled for midyear. LNG will be delivered to France at Montoir and to the U.S. at Trunkline LNG's Lake Charles terminal. Montoir is on schedule for a mid-year 1980 completion, but manpower shortages of skilled labor and bad weather have caused a five month slippage at Lake Charles. Delivery dates for the General Dynamics' ships *Lake Charles* and *Louisiana*, have been slipped correspondingly.

Considerable speculation has developed over Algeria's LNG plans involving Sonatrach's GL3-Z plant at Bethioua. Construction at the site was reportedly stopped in late September. Whether the halt represented a termination or just a delay while preparing design specifications for the LNG storage tanks is not known.

Concern over the potential effects of a catastrophic tank failure at one of the plants in the Industrial Zone is evidenced by Sonatrach's having sponsored a seminar on LNG/LPG storage in September. Sonatrach pointed to the significant investment represented in the Zone in terms of capital ($6 billion by 1985), trained manpower (13,000 in 1985), and foreign exchange earnings ($7 billion in 1985). Some form of "double integrity" storage plus additional security and fire protection provisions will undoubtedly be incorporated by the requirements. Technip-Snamprogetti, the process contractor, is winding the spiral heat exchangers for the nine trains each to have approximately 200 million cu ft per stream-day capacity. Most recent information is that the facility will be built, but about a year after the original startup date.

Concern over safety for LNG and LPG storage has been given new emphasis. In September, N. J. Cuperus, of Shell International Petroleum, presented a paper at the Tenth World Petroleum Congress entitled "Cyrogenic Storage Facilities for LNG and NGL." The paper presented a two-tank configuration concept, based on the assumption that small spills due to leaks *are* possible, and, that the conceivable failure of the inner tank is due to brittle failure. These configurations, then, would provide that a spill resulting from a conceivable, inner-tank failure will be contained by a second, independent tank ("double integrity").

Double integrity is being incorporated in designs for LNG terminals such as DFTG's at Wilhelmshaven, West Germany, and N.V. Nederlandse Gasunie's at Eemshaven, The Netherlands. DFTG chose Dykerhoff Widmann – CMP as contractor for its four 60,000-m^3 tanks, and Gasunie reportedly will select a contractor for its three 80,100-m^3 storage tanks in the near future. Construction of these terminals to receive LNG from Sonatrach's GL3-Z plant apparently have been delayed to phase with delays in construction of the export facility.

Asian Developments

Contractors selected by Malaysia LNG SDN. BHD. for construction of the LNG plant at Bintulu included Pullman Kellogg and Japan Gasoline Co., Ltd., for process design and general contracting, and Toyo Kanetsu K.K. for the LNG tanks. Air Products & Chemicals Inc. will supply the cyrogenic heat exchangers for the propane-stage mixed-refigerant cycle. Most of the remaining components will come from Japanese suppliers, as will engineering services.

Tokyo Electric Power Co., Ltd., and Tokyo Gas Co., Inc., reportedly approach agreements to purchase all the LNG. The 20-year contract is reported to call for delivery of about 312 billion cu ft per year – the output of the plant's three liquefaction trains. Deliveries are scheduled to begin in 1983 and reach a level of 88 billion cu ft per year by 1985, prior to full deliveries' beginning in 1986.

The Australian government issued export permits for North West Shelf gas in anticipation of signed contracts. Export of approximately 930 million cu ft per day is expected to begin in mid-1986. Japanese customers are reported to be completing purchase agreements for the gas supply. Total cost of the project has risen to an estimated $4.5 billion, several times the original estimate made in the mid-1970's.

Still in the about-to-be completed category is Pertamina's supply contract with Japanese customers, to result in a doubling of the Bontang Bay, East Kalimantan plant operated by P. T. Badak Natural Gas Liquefaction Co.

Potential Supply Sources

Based on accounts of recent offshore discoveries by European and U.S. companies, primarily in the northern coast area adjoining eastern Nigeria waters, speculation is that The Cameroons may become an LNG exporter. Major discoveries have been made by France's Elf Serepca and U.S. Shell's Pecten Cameroun and by a consortium of Mobil, Total, Ocelot, and Damson Oil. Total recoverable gas reserves of the Cameroon fields could be from 4 to 7 trillion cu ft, which would be enough to warrant a 500-to-750 million-cu-ft-per day export project. Developmental drilling to prove up reserves is reportedly planned for these permits, along with additional exploration drilling.

Although Argentina now imports Bolivian gas, its energy secretary has stated that his government will investigate gas export project possibilities. According to the energy secretary, the export options include LNG, pipeline export to neighboring countries, and use of feedstock for petrochemical export. Argentina is also expanding domestic consumption of gas to displace imported hydrocarbon liquids. Under recent agreement, N. V. Nederlandse Gasunie will head a consortium to build and manage a 2000-km (1200-mile) pipeline from the Neuquen and Mendoza fields to the Buenos Aires area. Gasunie will also assist in gas production and management of the gas distribution. A European banking group is arranging financing for the project, scheduled to begin deliveries in 1982. **P&GJ**

SCORECARD U.S. and Canadian LNG Peakshaving Facilities March 1980

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	Mbbl	Regasification—MMcfd Total Design Capacity	Runs	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
APCI-NEGEA Hopkinton, Mass.	18.5	2000 (2 at 290)	580	248	4 at 62	8	Submrgd	Aboveground, 9% nickel	CBI	Cryo-Methane	Cascade	1967—plant, 1971 on new tanks
APCI-NEGEA Hopkinton, Mass.	—	1000	290	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1975—third tank
ALABAMA GAS CORP. Birmingham, Ala.	4.65	625	180	127/85	3 at 42.5	10	Submrgd	Aboveground, 9% nickel	CBI	Air Products & Chemicals, Inc.	Cascade	1965
ALABAMA GAS CORP. Birmingham, Ala.	—	625	180	42.5	1 at 42.5		Submrgd	Aboveground, aluminum	CBI	—	—	1971—second tank
ALABAMA GAS CORP. Coosada, Ala.	2.7	600	175	80	2 at 40	15	Submrgd	Aboveground, aluminum	CBI	CBI	Modified Cascade	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga.	10.0	1000	290	200	3 at 100	5	Uniflux	Aboveground, aluminum	CBI	Air Liquide	TEAL Expander Process boost	1972
ATLANTA GAS LIGHT CO. Riverdale, Ga.		1500	450	—	—	—	—	Aboveground, 9% nickel	CBI	—	—	1973
ARKANSAS-MISSOURI POWER CO. Yarbro, Ark.	0.66	374 (2 x 55)	110	66	2 at 33	6	Direct Fired	Aboveground, aluminum	Brown, Minneapolis Tank & Fab. Co.	Process Constructors, Inc.	Stirling	1973—(1972 as satellite)
BALTIMORE GAS & ELEC. CO. Baltimore, Md.	2.75	500 (2 x 72.5)	145	187.5/125	3 at 62.5	5	Submrgd	Aboveground, aluminum	CBI	CBI	Expander	1971
BALTIMORE GAS & ELEC. CO. PLANT No. 2, Baltimore, Md.	2.4	500	145	62.5	1 at 62.5	8	Submrgd	Aboveground, aluminum	CBI	CBI	MRL	1973
BAY STATE GAS CO. Ludlow, Mass.	7.5	1000	290	55	1 at 25 2 at 15	20	Uniflux	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1973
BOSTON GAS CO. Boston, Mass.	6.0	1000	290	187.5/125	3 at 62.5	8	Submrgd	Aboveground, 9% nickel	CBI	CBI	Expander	1968
BOSTON GAS CO. Boston, Mass.	—	1120	301	—	—	—	—	Aboveground, aluminum	CBI	—	—	1971—second tank
BOSTON GAS CO. Lynn, Mass.	7.85	1000	290	86.4/57.6	3 at 28.8	12	Submrgd	Aboveground, 9% nickel	PDM	Air Products & Chemicals, Inc.	MCR	1972
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY Vancouver, B.C.	2.5	625	180	150/100	3 at 50	6	Submrgd	Aboveground, 9% nickel	Pittsburgh Des Moines Steel	Air Liquide	TEALARC	1971
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	5.68	625	175	100	2 at 50	4	Direct Fired	Aboveground, 9% nickel	CBI	American Messer	Expander	1968
BROOKLYN UNION GAS CO. Brooklyn, N.Y.	—	1000	290	50	2 at 25	—	Direct Fired	Aboveground, 9% nickel	CBI	—	—	1971—second tank
				125	2 at 62.5	--	Submrgd					
				125	2 at 62.5	--	Submrgd					1979
CHATTANOOGA GAS CO. Chattanooga, Tenn.	10.0	1200	348	90/60	3 at 30	2.	Direct Fired	Aboveground, 9% nickel	PDM	J. F. Pritchard	PRICO	1973
CITIZENS GAS & COKE UTILITY Beech Grove, Ind.	5.0	1000	290	180	3 at 60	5	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1972
COMMONWEALTH NATURAL GAS CO., Tidewater, Va.	5.0	1200	348	105	3 at 35	12	Direct Fired	Aboveground, 9% nickel	PDM	Envirogenics	Cascade	1972
CONNECTICUT NATURAL GAS CORP., Rocky Hill, Con	6.6	1200	348	80/55	2 at 25 1 at 30	24	Vapor Trsfr Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1972
CONSOLIDATED EDISON CO. Astoria, N.Y.	6.0	1000	290	300/240	5 at 60	4	N.A.	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1974
DELMARVA POWER & LT. CO. Wilmington, Del.	1.71	250	72.5	50	2 at 25	5	Direct Fired	Aboveground, aluminum	CBI	Lotepro-Linde AG	Expander/ Nitrogen	1972
EAST TENNESSEE NATURAL GAS CO. Fordtown, Tenn.	5.5	1200	348	150	2 at 75	8	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1975
ENERGY TERMINAL SERVICES CORP., Staten Island, N.Y.	15.0	3000	900	360	4 at 90	8	Direct Fired	Prestressed concrete	Preload/Walsh	NA	NA	1982 planned
(Conversion of part of terminal capacity to peakshaving. Uses one of two storage tanks and all of vaporization capacity.)												
FALL RIVER GAS CO. Fall River, Mass.	0.5	150	45	10	1	15	Direct Fired	Aboveground, 9% nickel	PDM	CVI Corp.	Dual J. T. Cycle	1970
GAS LIGHT CO. OF COLUMBUS Columbus, Ga.	1.7	500	145	60	2 at 30	8	Indirect Fluid	Aboveground, aluminum	CBI	CBI	Expander	1974
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	10.0	1000	290	180	3 at 60	16	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1969
GAZ METROPOLITAIN, INC. Montreal, Que., Canada	—	1000	290	—	—	—	—	Aboveground, 9% nickel	Horton (CBI)	—	—	1972—second tank
INTERMOUNTAIN GAS CO. Boise, Idaho	4.0	600	175	90/60	3 at 30	10	Submrgd	Aboveground, aluminum	PDM	Lotepro-Linde AG	Expander/ Nitrogen	1974
IOWA-ILLINOIS GAS & ELEC. CO. Bettendorf, Iowa	2.0	500	145	50	2 at 25	10	Uniflux	Aboveground, aluminum	CBI	CBI	MRL	1972
IOWA POWER & LT. CO. Des Moines, Iowa	2.0	400	116	30	2 at 15	13	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	MRL	1975
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	2.5	400	117	30	2 at 15	26	Intermed. Fluid	Aboveground, aluminum	PDM	APCO (prime) Air Liquide (liquefaction)	TEALARC	1976
IOWA PUBLIC SERVICE CO. Waterloo, Iowa	—	400	117	—	—	—	—	Aboveground, aluminum	CBI	—	—	1978—second tank
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.3	400	116	30/15	2 at 15	26	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1973
KOKOMO GAS & FUEL CO. Kokomo, Ind.	1.25	—	—	—	—	—	—	(Second liquefaction unit)		CBI	MRL	1974
LONG ISLAND LIGHTING CO. Holbrook, N.Y.	3.0	600	175	200/150	4 at 50	4	Submrgd	Aboveground, 9% nickel	PDM	Lotepro-Linde AG	Cascade/ Mixed Refrigerant	1971
LOWELL GAS CO. Lowell, Mass.	4.5	1000	290	70/70	2 at 30 1 at 10	18	Direct Fired	Aboveground, 9% nickel	Graver/ Envirogenics	Envirogenics	Expander	1969
MEMPHIS LIGHT, GAS & WATER DIV., Memphis, Tenn.	5.0	1000	290	201	3 at 67	5	Submrgd	Aboveground, 9% nickel	CBI	Air Liquide	Cascade	1967
METRO. UTILITIES DISTRICT Omaha, Nebr.	6.0	1000	290	60/30	2 at 30	33	Submrgd	Aboveground, 9% nickel	CBI	Lotepro-Linde AG	Expander/ Nitrogen	197[illegible]
MINNESOTA GAS CO. Burnsville, Minn.	5.0	1000	290	80	2 at 40	12	Intermed. Fluid	Aboveground, 9% nickel	CBI	CBI	MRL	1978
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Direct Fired	Aboveground, 9% nickel	CBI	J. F. Pritchard	PRICO	1974
NORTHERN IND. PUBLIC SERVICE CO. La Porte, Ind.	10.0	2000	580	300/200	3 at 100	10	Submrgd	Aboveground	CBI	Lotepro	Mixed Refrigerant	1980—second facility—U.C.
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	2.5	625	180	85	3 at 42.5	7	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Air Liquide	TEALARC	1968
NORTHERN & CENTRAL GAS CO. Hagar, Ontario	—	—	—	—	1 at 42.5	—	Submrgd	Aboveground, 9% nickel	Horton (CBI)	Lotepro Engr.	—	1977
NORTHERN NATURAL GAS CO. Wrenshall, Minn.	10.0	2165	630	200	2 at 100	10	Submrgd	Aboveground, 9% nickel	PDM	SD Plants	TEALARC	1975
NORTHERN NATURAL GAS CO. Ventura, Iowa	14.5	2165	630	300	3 at 100	7	Submrgd	Aboveground, 9% nickel	PDM	NNG	PRICO	1978
NORTHERN STATES POWER CO. Eau Claire, Wisc.	2.0	270	78	24/24	2 at 12	11	Direct Fired	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHERN STATES POWER CO. Wescott, Minn.	10.0	2000	580	75	2 at 37.5	28	Direct Fired	Aboveground, 9% nickel	CBI	CBI	MRL	1975
NORTHWEST NATURAL GAS CO. Portland, Ore.	2.5	625	175	200	2 at 60 1 at 20 2 at 30	10	Direct Fired Submrgd	Aboveground, aluminum	CBI	CBI	Expander	1969
NORTHWEST NATURAL GAS CO. Newport, Ore.	5.0	1200	348	100/100	2 at 50	12	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL/ CRYEX	1977
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	225	3 at 75	8	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1975
NORTHWEST PIPELINE CORP. Plymouth, Wash.	6.0	1200	348	75	1 at 75	15	Submrgd	Aboveground, aluminum	PDM	Air Liquide	TEALARC	1979
PEOPLES GAS, LIGHT & COKE Fisher, Ill.	10.0	2000	580	300/200 (2 x 290)	3 at 67 1 at 100	10	Direct Fired	Aboveground, aluminum	CBI	CBI	Expander	1972
PHILADELPHIA ELECTRIC CO. West Conshohocken, Pa.	6.6	1200	348	310/186	5 at 62	4	Submrgd	Aboveground, 9% nickel	CBI	Airco Cryoplants	Expander/ Nitrogen	1972
PHILADELPHIA GAS WORKS Philadelphia, Pa.	25.0	4000	1166 (2 x 583)	500/400	5 at 100	10	Intermed. Fluid	Aboveground, Prestressed concrete	Preload	J. F. Pritchard	Cascade	1969—Plant operable; 1974 on tanks
PIEDMONT NATURAL GAS CO. Charlotte, N. Car.	5.0	1000	290	150	3 at 50	7	Direct Fired	Aboveground, 9% nickel	CBI	CBI	MRL	1973

Cont'd

U.S. and Canadian LNG Peakshaving Facilities

March 1980

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	Storage Capacity, MBbl	Regasification—MMcfd: Total Design Capacity	Pumps	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
PUBLIC SERVICE CO. OF NORTH CAROLINA, Cary, N. Car.	3.0	1000	290	100	2 at 50	6	Interm. Fluid	Aboveground, 9% nickel	CBI	CBI	MRL	1976
ROANOKE GAS CO. Roanoke, Va.	1.0	200	58.5	20	2 at 10	13	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	MRL	1972
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 1 Plant	2.0	625	175	120/60	2 at 60	10	Submrgd	Aboveground, 9% nickel	CBI	American Messer	Expander	1965
SAN DIEGO GAS & ELECTRIC CO., Chula Vista, Calif. No. 2 Plant	7.0	1200	348	180/120	3 at 60	10	Submrgd	Aboveground, 9% nickel	CBI	Airco Cryoplants	Expander/ Nitrogen	1970
SOUTH CAROLINA LNG CO. Bushey Park, So. Car.	6.0	1000	290 (2 x 145)	60	2 at 30	17	Intermed. Fluid	Aboveground, aluminum	PDM	APCO (prime) Air Liquide	TEALARC	1976
SOUTHERN CONNECTICUT GAS CO., Milford, Conn.	6.6	1200	348	90	2 at 30 1 at 30	14	Vapor Trsfr Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander/ Nitrogen	1972
SOUTHWEST GAS CORP. Lovelock, Nev.	5.0	1000	290	106/70	3 at 35	10	N.A.	Aboveground 9% nickel	CBI	CBI	MRL	1981—Planned
TENNESSEE NATURAL GAS LINES, INC., Nashville, Tenn.	5.0	1000	290	150/100	3 at 50	10	Direct Fired	Aboveground, aluminum	CBI	CBI	MRL	1973
TEXAS EASTERN TRANS. CO. Staten Island, N.Y.	7.65	2000	600	292/195	3 at 97.5	10	Direct Fired	Aboveground, 9% nickel, both walls	N.A.	Texas Eastern Cryogenics	TEALARC	1970; storage destroyed 1973; new double-wall tank—planned on same foundation
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	7.0	1000	290	200/200	2 at 100	5	Intermed. Fluid	Aboveground, aluminum	CBI	J. F. Pritchard	Cascade	1965; 1970 on new tank
TRANSCONTINENTAL GAS P.L. CORP., Hackensack, N.J.	—	1000	290	200/200	2 at 100	—	Uniflux	Aboveground, 9% nickel	PDM	—	—	1974—second tank
UGI CORP. Temple, Pa.	2.0	250	73	30/30	3 at 10	8	Submrgd	Aboveground, 9% nickel	PDM	Airco Cryoplants	Expander	1973 (1972 as satellite)
UTILITIES BOARD Trussville, Ala.	5.0	400	116	20	2 at 10	—	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	MRL/ CRYEX	1976
WISCONSIN NATURAL GAS CO. Oak Creek, Wisc.	0.75	256	72	50/25	2 at 25	10	Intermed. Fluid	Aboveground, aluminum	CBI	CBI	Cascade	1965

International LNG Peakshaving Facilities

Company and Plant Site	Liquefaction Plant Capacity, MMcfd/day	Storage Capacity, MMcf	Storage Capacity, MBbl	Regasification—MMcfd: Total Design Capacity	Pumps	No. of Days	Type	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
BRITISH GAS CORP. Avonmouth, Avon	10.0	1000	290	270	3 at 90	4	Submrgd	Aboveground, aluminum	Whessoe, Ltd.	Cryoplants, Ltd.	MCR	1978—Plant 1979—Tank
BRITISH GAS CORP. Avonmouth, Avon	—	1000	290	180	2 at 90	—	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	—	—	1979—Second tank
BRITISH GAS CORP. Glenmavis, Scotland	5.0	1000	290	240	4 at 60	4	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Cryoplants, Ltd	MCR	1979—(North Sea Gas)
BRITISH GAS CORP. Glenmavis, Scotland (2nd plant)	10.0	1000	290	120	2 at 60	17	Submrgd	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Cryoplants, Ltd.	MRC	1975
BRITISH GAS CORP. Partington, Cheshire, England	10.0	2000	580 (2 x 290)	450	5 at 90	4	Submrgd	Aboveground, 9% nickel	Wm. Neill & Son (St. Helens) Ltd. (PDM Lic.)	Cryoplants, Ltd	MRC	1973
BRITISH GAS CORP. Partington, Cheshire, England (2nd plant)	10.0	2000	580 (2 x 290)	270	3 at 90	2	Submrgd	Aboveground, aluminum	Whessoe, Ltd.	Cryoplants, Ltd.	MRC	1974 on tank 1975 on plant
BRITISH GAS CORP. Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Aboveground, 9% nickel	Motherwell Bridge Engrg. Ltd.	Petrocarbon Development Ltd.	Open/ Expander	1980—Planned
BRITISH GAS CORP. Isle of Grain, Kent	10.0	2000	580 (2 x 290)	390	3 x 130	5	Direct Fired	Aboveground, 9% nickel	Whessoe, Ltd.	Petrocarbon Development, Ltd.	Nitrogen Expander	1981—Planned
BRITISH GAS CORP. Dynevor Arms, S. Wales	10.0	1000	290	180	2 x 90	5	N.A.	Aboveground	N.A.	Snamprogetti	MCR	1983—Planned
BRITISH GAS CORP. Canvey Island, England	10.3	—	—	(Production plant only) (Reliquefaction)				—	—	Air Products, Ltd.	APCI-MCR	1972
N.V. NEDERLANDSE GASUNIE Maasvlakte, The Netherlands	12.4	2790	860 (2 x 430)	930	8 at 90 3 at 70	4	Submrgd	Aboveground, 9% nickel	Nederhorst Steel	Linde A.G.	Expander/ Nitrogen	1977
DISTRIGAZ, S.A. Zeebrugge, Belgium	12.3	2480	716 (2 x 358)	391	5	6	Submrgd	Aboveground, 9% nickel	Boelwerft/ CMP/CBI	Linde A.G.	Nitrogen/ Expander	1978
STUTTGART CITY UTILITIES Stuttgart, W. Germany	3.4	665	193	68.9	3	10	Submrgd	Aboveground, 9% nickel	Linde A.G.	Linde A.G.	Open Mixed Refrigerant	1971—Peakshaving plant
THYSSEN GAS GmbH Duisburg, Hamborn, W. Germany	2.1	550	145	135/90	3 at 45	5.5	Submrgd	Aboveground, 9% nickel	CBI	CBI	MRL	1976
GAS & FUEL CORP. OF VICTORIA Dandenong, Victoria, Australia	5.0	500	145	125	2 at 62.5	4	Submrgd	Aboveground, 9% nickel	CBI Pty. Ltd.	Cryoplants, Ltd.	MRC	1980—U.C.

International Baseload LNG Liquefaction Facilities

Company and Plant Site	Liquefaction Plant Capacity, MMcf/day	Storage Capacity, MMcf	Storage Capacity, MBbl	Type of Storage Container	Storage Contractor	Liquefaction Plant Contractor	Type of Cycle	Year of Operation
ARCTIC PILOT PROJECT Bridport Inlet, Melville Island, Canada	275	NA	NA	NA	N.A.	N.A.	Precooled TEALARC	1983
CAMEL (GL 4-Z) Arzew, Algeria	(Barge-mounted) 200.0	1840 total	210 (3x70) 310	Aboveground, (2-aluminum, 1-9% nickel) Frozen hole	CBI lic. Pritchard	TECHNIP Pritchard	Cascade	1963 et. seq. LNG for export to England, France
SONATRACH—(GL 1-Z) Arzew, Algeria	1100.0	7000	1890 (3 x 630 tanks)	Aboveground, 9% nickel	Toyo Kanetsu, K.K., (PDM Lic.)	Bechtel Corp. & Chemico	APCI-MCR	1978
SONATRACH—(GL 2-Z) Arzew, Algeria	1000	6000 (3 x 600)	1800	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Pullman Kellogg	APCI-MCR	1980—U.C.
SONATRACH—(GL 3-Z) Arzew, Algeria	1800	N.A.	N.A.	Aboveground	N.A.	Foster-Wheeler	TEALARC	Mid-'80's
SONATRACH—(GL 1-K) Skikda, Algeria	430.0 (3 trains)	2500	700 (2 x 350)	Aboveground, 9% nickel	CMP/CBI	TECHNIP	TEALARC	1972
SONATRACH—(GL 2-K) Skikda, Algeria	170.0 (1 train)	1250	350	Aboveground, 9% nickel	CBI	Pullman-Kellogg	PRICO	1980
SONATRACH—(GL 3-K) Skikda, Algeria	350.0 (2 trains)	3500	880 (2 x 440)	Aboveground, 9% nickel	CBI/Whessoe	Pullman-Kellogg	PRICO	1980
ESSO LIBYA Marsa el Brega, Libya	[illegible]85.0	2100	630 (2 x 315)	Aboveground, 9% nickel	CBI	Esso R&E-Bechtel—SNAM Progetti	APCI-MCR	1970
BRUNEI LNG Lumut, Bruem, Borneo	750.0	4050	1131 (3 at 377)	Aboveground, 9% nickel	Toyo Kanetsu K.K., (PDM Lic.)	Japan Gasoline Co.—UOP	APCI-MCR	1973
ABU DHABI GAS LIQUEFACTION CO. LTD., Das Island, Abu Dhabi	350.0	8800	1920 (2 x 960)	Aboveground, 9% nickel	I.H.I.	Bechtel-Chiyoda	APCI-MCR	1977
PHILLIPS-MARATHON Kenai, Alaska	185.0	2300	675 (3 x 225)	Aboveground, aluminum	CBI	Phillips-Bechtel	Cascade	1969
PACIFIC ALASKA LNG. CO. Cook Inlet, Alaska	400.00	3000	1100 (2 x 550)	Aboveground, 9% nickel	CBI	Fluor Corp.	APCI-MCR	1982—Planned
PERTAMINA/MOBIL Arun, N. Sumatra, Indonesia	1200	8350	3200 (4 x 800)	Aboveground, 9% nickel	Toyo Kanetsu K. K., (PDM Lic.)	Bechtel, Inc.	APCI-MCR	1978
PERTAMINA/HUFFCO Badak, E. Kalimantan, Indonesia	550	8330	2400 (4 x 600)	Aboveground, 9% nickel	Hitachi Zosen—CBI	Bechtel, Inc.	APCI-MCR	1977
GAS DE CHILE (ENAP) Cabo Negro, Chile	250	N.A.	N.A.	N.A.	N.A.	APCI	APCI-MCR	1984—Planned
MALAYSIAN LNG SDN. BHD. Bintulu, Sarawak, Malaysia	850	5080	1636 (4 x 409)	N.A.	I.H.I.	Pullman Kellogg—Japan Gasoline Co. Ltd.	API-MCR	1982—U.C.
BONNY LNG Bonny, Nigeria	2000	N.A.	N.A.	N.A.	N.A.	Phillips	"Optimized" cascade	1980's—Planned
WOODSIDE LNG PTY. LTD. Withnell Bay, Western Australia	900	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1985

Import/Receiving Terminals March 1980

Company and Plant Site	Storage Capacity MMcf	Storage Capacity MBbl	Capacity	Regasification— MMcfd Runs	Regasification— MMcfd Type	Type of Storage Container	Storage Contractor	[illegible] Contractor	Year of Operation
BRITISH GAS CORP. Canvey Island, England	4000 1400	1200 352 (6 -60+2-16)	300	3 at 50 1 at 50 2 at 50	Submrgd Seawater Intermediate fluid/seawater	Frozen hole Aboveground, aluminum	Conch/McAlpine APV and Whessoe	Gas Corp.	1958, 1963, 1967
GAZ DE FRANCE Montoir de Bretagne	5300	1512 (2 x 756)	910	4 at 228	Estuary water	Aboveground, concrete	Chantiers Modernes; Europe Etudes: Technigaz; Bugnier-Schmidt-Laurent	Gaz de France	1980—U.C.
GAZ DE FRANCE Le Havre, France	792	229.5 (3 x 76.5)	75	3 at 25	Seawater Fluid	Aboveground, 9% nickel	CBI lic.	Gaz de France	1963
GAZ DE FRANCE Fos-Sur-Mer, France	1500	450 (2 x 225)	424	4 at 108	Intermed. Fluid	Aboveground, aluminum	CBI lic.	Gaz de France	1971
GAZ DE FRANCE Fos-Sur-Mer	1000	290	425	—	—	Aboveground, 9% nickel	C.M.P.		1979—third tank
ENAGAS, S.A., Barcelona	1800	500 (2 x 250)	155	1 at 67 2 at 44	Seawater	Aboveground, concrete	Preload/Christiani and Nielsen	Esso R&D	1969
	1800	500	268	2 at 67 2 at 67	Seawater submrgd	Aboveground, 9% nickel	Felguera Provence	CBI	1974
	1800	500	536	4 at 134	Seawater	Aboveground, concrete	Preload Auxini	Preload Auxini	1979 U.C.
SNAM (ENI) La Spezia, Italy	2100	630 (2 x 315)	353	2 at 1765	Intermed. Fluid	Aboveground, 9% nickel	SAIPEM (PDM lic.)	Esso R&D	1969
N.V. NEDERLANDSE GASUNIE, Eemshaven, Groningen, The Netherlands	5300	1512 (3 x 504)	583	N.A.	Combination seawater/submrgd; possibly cold energy/recovery	Aboveground, concrete and 9% nickel	N.A.	N.A.	1984—Planned
DEUTSCHE FLUSSIGERD GAS TERMINAL GmbH Wilhelmshaven, Ger.	5306	1508 (4 x 377)	2160	16 at 135	Submrgd/seawater	Aboveground, concrete and 9% nickel	Dykerhoff Widmann — CMP	Linde A.G.	1983—Planned
DISTRIGAZ, S.A. Zeebrugge, Belgium	9072	2520 (4 x 630)	1000	10 at 100	Submrgd.	Half underground	N.A.	Tractabel	1986—Planned
TOKYO GAS CO./TOKYO ELECTRIC, Negishi, Yokohama, Japan	3480	1010 (2 x 284) (2 x 221)	224 56	4 at 56 1 at 56	Seawater Submrgd	Aboveground, 9% nickel	IHI	Tokyo Gas Co.	1969
	219	63	56	1 at 56	Submrgd	Inground concrete and SUS membrane	IHI		1970
	1287	378				Inground concrete and SUS membrane	IHI		1972
	979	284	191	1 at 93 1 at 49 1 at 49	Seawater Seawater Submrgd	Aboveground, 9% nickel	IHI	Tokyo Gas Co.	1972
	544	158				Aboveground, 9% nickel	IHI		1973
	2038	599	110	1 at 110	Submrgd	Inground concrete and SUS membrane	IHI/Kajima	Tokyo Gas Co.	1977
	2038	599	110	1 at 110	Submrgd	Inground concrete and SUS membrane	IHI/Kajima		1978
	2038	599	110	1 at 110	Seawater	Inground concrete and SUS membrane	Nippon Kokan	Tokyo Gas Co.	1979 1981 (U.C.)
	2038	599				Inground concrete and SUS	Kawasaki Heavy Industries		1982 (U.C.)
TOKYO GAS CO./TOKYO ELECTRIC, Sodegaura, Chiba, Japan	1931	568 (2 x 284)	330	3 at 66 2 at 66	Seawater Submrgd	Aboveground, Al	IHI	Tokyo Gas Co.	1973
	1287	378	418	3 at 66	Seawater	Aboveground, Al	IHI	Tokyo Gas Co.	1974
	2574	756 (2 x 378)		4 at 55	Seawater	Inground concrete and SUS membrane	IHI		
	1931	568 (2 x 284)				Aboveground, Al	IHI		1974
	2574	756 (2 x 378)				Aboveground, Al	IHI		1975
	1287	378	340	2 at 110 1 at 60 1 at 60	Seawater Seawater Submrgd	Inground concrete and SUS membrane	IHI	Tokyo Gas Co.	1976
	2574	756 (2 x 378)				Aboveground, Al	IHI		1977
	5148	1512 (4 x 378)	613	2 at 110 2 at 131 1 at 131	Seawater Seawater Submrgd	Inground concrete and SuS membrane	IHI	Tokyo Gas Co.	1977
	2574	756 (2 x 378)				Inground concrete and SUS membrane	Kajima-MHI		1978
	1330	756 (1 x 391) (1 x 365)				Inground concrete and SUS membrane	IHI		1979
	2574	756 (2 x 378)				Inground concrete and SUS membrane	Kajima-MHI		1979
	1287	378				Inground concrete and SUS membrane	Kajima-IHI		1981 (U.C.)
	5578	1640 (2 x 820)				Inground concrete and SUS membrane	MHI-Kajima IHI-Shimizu		1982 (U.C.)
OSAKA GAS CO. Semboku I, Osaka, Japan	3920	1120 (1 x 280—underground) (3 x 280—aboveground)	160	3 at 40 1 at 40	Seawater Intermed Fluid	Aboveground, aluminum (1) 9% nickel (2) Inground concrete and SUS membrane	IHI IHI/Ohbayashi	Osaka Gas	1971
OSAKA GAS CO. Semboku II, Osaka, Japan	16,206	4700 (10 x 470)	540	7 at 60 2 at 60	Seawater Thermal Fluid	Aboveground, aluminum (3) 9% nickel (7)	IHI and Toyo Kanetsu K.K.	Osaka Gas	1977
KITA KYUSHU LNG CO. Tobata, Fukuoka, Japan (Kyushu Electric/Nippon Steel)	7722	2268 (6 x 378)	678 142	4 at 142 1 at 110 1 at 142	Seawater Submrgd Seawater	Aboveground, 9% nickel	IHI Toyokanetsu	IHI	1977 1979
CHUBU ELECTRIC/TOHO GAS CO. Chita, Aichi, Japan	3218	1892	318 (2 x 473) (2 x 473)	3 at 142 1 at 66 4 at 22 1 at 22	Seawater Submrgd Seawater Submrgd	Aboveground, Al Aboveground, 9% Nickel	IHI Toyokanetsu	IHI	1977
KANSAI ELECTRIC/OSAKA GAS Himeji, Hyogo, Japan	2995	1761 (3 x 503) (1 x 252)	625	5 at 125	Seawater	Aboveground 9% Nickel—2 tanks Aluminum—1 tank Aboveground Aluminum	IHI	IHI	1979
ALGONQUIN LNG INC. Providence, R.I.	6000	1800 (3 x 600)	300 375	3 at 100 3 at 125	Direct Fluid Seawater	Aboveground, 9% nickel	CBI	CBI	1973—1st tank, 1975—2 add'l tanks planned
COLUMBIA LNG CORP. & CONSOLIDATED SYSTEM LNG. CO., Cove Point, Maryland	5000	1500 (4 x 375)	1000 200	10 at 100 2 at 100	Intermed. Fluid	Aboveground, aluminum	PDM	Pullman Kellogg & Raymond Technical	1977
DISTRIGAS CORP. Everett, Mass.	3250	974 (1 x 374+1×600)	135	3 at 45	Submrgd	Aboveground, 9% nickel	CBI	CBI	1971
EL PASO LNG TERMINAL CORP. Port O'Connor, Texas	6804	1890 (3 x 630)	1050	10 at 105	Seawater	Aboveground	N.A.	N.A.	1980's—Planned
NATURAL GAS PIPELINE CO. OF AMERICA (Peoples Gas) Ingleside, Tex.	6804	1890 (3 x 630)	1124	11 at 104	Seawater Submrgd	Aboveground, 9% nickel	N.A.		1980's—Planned
SOUTHERN ENERGY CO. Elba Island, Ga.	4000	1200 (3 x 400)	540	5 at 108	Submrgd	Aboveground, aluminum	CBI	Bechtel Inc. and Raymond Technical	1977
TRUNKLINE LNG CO. Lake Charles, La.	6000	1800 (3 x 600)	700	7 at 100	Submrgd	Aboveground, 9% nickel	PDM	Pullman Kellogg Co. and Raymond Technical	1980 (U.C.)
WESTERN LNG TERMINAL CO. Little Cojo, Calif.	5775	1650 (3 x 550)	1200	12 at 100	Direct seawater	Aboveground, 9% nickel	N.A.	Fluor	1984—Planned

International LNG Report

Steady Growth Seen In Next Decade For World Trade In LNG

by P. J. Anderson, *Contributing Editor*

By 1979, international trade in LNG had grown from an initial contractual level of 150 million cu ft per day to a level of 4.482 billion cu ft per day, which represents a 30-fold increase in the last 15 years. Deliveries in 1978 amounted to approximately 2.525 billion cu ft per day. Because two new projects were coming on-stream in 1978, deliveries actually approached 75% of anticipated quantities rather than the apparent level of 56%. Although many projects did deliver at contract quantities, several were plagued by technical problems with the liquefaction and transportation segments of the chain. The number of LNG-exporting countries also has increased from one to six in the intervening 15 years.

Those who have not been part of this industry during the last 20 years might conclude that 23.5% annual growth rate is truly remarkable and worthy of great praise. So it is! It is praiseworthy not just because the LNG trade has reached its originally projected goals, but because of the determination of its promoters in achieving this comparatively modest trading level. Original projections for LNG's future make its present achievements pale by comparison.

What, then, do the next 10 years hold for this industry? Based on past actual performance versus that projected, it appears that growth will continue at a slow pace, with a limited number of new exporters entering.

Between now and the mid-1980's, the size of world trade in LNG could well be expected to more than double with the implementation of those trades considered to be "firm" or "under construction" (Table 3). These projects, which total 4.835 billion cu ft per day, represent a slowing of the annual growth rate to about 16%. Some of the projects involved are not as firm as might be desired.

By the time this article appears, a better definition may exist of the course of petitions filed with the U.S. Court of Appeals for the District of Columbia Circuit by the intervenors in the Pac-Indonesia and Pac-Alaska Projects. Also, results of seismic studies at the Little Cojo terminal site near Point Conception, Calif., should be further along, perhaps far enough

TABLE 1
LNG Deliveries In 1978

	Project	Ports	Volume, 10^9 CF
1.	Algeria — U.K.	Arzew — Canvey Island	28.93
1a.	Algeria — France	Arzew — Le Havre Skikda — Le Havre Total	11.34
2.	Libya — Spain	Marsa el Brega — Barcelona	41.36
2a.	Libya — Italy	Marsa el Brega — La Spezia	84.48
3.	Alaska — Japan	Kenai — Negishi	48.40
4.	Algeria — Spain	Skikda — Barcelona	10.29
5.	Algeria — France	Skikda — Fos Sur Mer Arzew — Fos Sur Mer Total	99.07
6.	Brunei — Japan	Lumut — various Japanese ports (Senboku, Sodegaura, Negishi) Total	266.67
7.	Abu Dhabi — Japan	Das Island — Sodegaura	64.87
8a.	Indonesia — Japan	Bontang — various Japanese ports (Senboku, Tobata, Chita) Total	162.40
8b.	Indonesia — Japan	Arun — various Japanese ports (Senboku, Tobata, Chita) Total	19.25
9.	Algeria — U.S.	Arzew — Cove Point Arzew — Elba Island Total	69.86
10a.	Algeria — U.S.	Skikda — Everett Arzew — Everett Total	14.60

TABLE 2
Base-Load LNG Import Projects
(Currently Operational)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Algeria — United Kingdom Arzew — Canvey Island	1964	15	CAMEL (SONATRACH) British Gas Corp Conch International	100	2. United Kingdom	27.400
Algeria — France Arzew — Le Havre	1964	25	CAMEL (SONATRACH) Gaz de France	50	1. France	25.500
Alaska — Japan Kenai — Neigishi	1969	15	Phillips Petroleum Co Marathon Oil Co Tokyo Electric Tokyo Gas	135	2. Sweden	71,500
Libya — Italy Marsa el Brega — La Spezia	1969	20	Esso Standard Libya SNAM	235	3. Italy	40.000
Libya — Spain Marsa el Brega — Barcelona	1969	15	Esso Standard Libya	110	1. Spain	40.000
Brunei — Japan Lumut-Sodegura — Neigishi, Semboku	1972	20	Brunei LNG, Coldgas Trading Osaka Gas, Tokyo Gas Tokyo Electric Power	737	7. France	75.000
Algeria — France Skikda — Fos s/Mer	1972	25	SONATRACH Gaz de France	350	2. France	40.000
Algeria — U S Skikda — Everett	1971	20	SONATRACH Alocean Distrigas	115	1. France	1-125.300
Algeria — Spain Arzew — Barcelona	1974 (full delivery 1980)	15	SONATRACH Empresa Nacional de Gas	450 (full delivery 150)	1. NA 1. France	30.000 125.300
Abu Dhabi — Japan Das Island — Tokyo	1977	20	Abu Dhabi Liquefaction Co Tokyo Electric Power	450	3. Norway 1. Norway	125.000 87.600
Indonesia — Japan North Sumatra, East Kalimantan — Japanese Terminals	1977	20	Pertamina, Osaka Gas Kunsai Electric Power Chibu Electric Power Kyushu Electric Power Nippon Steel	1050	7. U S	125.000
Algeria — U S Arzew — Cove Point, Elba Island	1978	20	SONATRACH El Paso LNG Co (Algerian Subsidiary) Columbia LNG Corp Consolidated System LNG Co Southern Energy Co	1000	3. France 6. U S	125.000 125.000

to assess the suitability of the site. Algeria's plans to construct and export LNG from its GL3-Z facility at Bethioua are not yet fully resolved. Although it appears probable that the facility will be constructed, implementation will be delayed for over a year.

If Algerian exports and U.S. imports from Indonesia and Alaska are not realized, some of these lost volumes might be made up by additional sales to Japan from Pertamina's North Sumatra, Indonesia, facility, as well as through the anticipated implementation of the expansion of the East Kalimantan, Indonesia, facility. The net effect would appear to be a decline in traded volume of about 3 billion cu ft per day. The remaining 1.8 billion cu ft per day in anticipated growth would correspond to an annual growth rate of just above 7%. The impact on the overall size of the industry of a single project or construction of a large export facility illustrates its relatively small size. Implementation of these firm projects will add Malaysia to the list of exporting nations.

Planned Projects

Several projects are in various stages of planning. The probability of their implementation varies from near certainty for the expansion of Pertamina's East Kalimantan facility to negligible for Chilean exports to the U.S. With the exception of the Indonesian project, none of these planned projects would appear likely to be implemented until the second half of this decade.

Those projects with a greater than 50% probability of implementation appear to be Pertamina's expansion for East Kalimantan, Nigeria, Algeria's German export, and Australia. Expansion of Pertamina's North Sumatra facility would appear to depend upon implementation of the U.S. import project.

Implementation of Arctic Island projects appears dependent upon several considerations including Canadian National Energy Board decisions, governmental policies, and the ultimate cost and reliability of arctic transportation. Exports to the United States either from Chile or the Soviet Union are politically unacceptable at this time.

To the list of projects with favorable odds for implementation could be added the project for Trinidad and Tobago. Here, agreement between participants on contracts necessary to implement a project is expected by year-end. Assigning probabilities and discounts leads to the conclusion that, by the end of this decade, another 3.5 billion cu ft per day of LNG projects could be implemented. Combined with the previously discussed projects that could be implemented during the first half of the decade, a growth rate for the 1980's of about 11% in LNG volume appears reasonable. During the second half of the decade Nigeria, Australia, Trinidad and Tobago, and possibly Canada could become LNG exporters.

Beyond 1990, several LNG export projects could be implemented. These projects involve countries or regions with gas reserves large compared with indigenous requirements. The Middle East, West African countries such as The Cameroons, and the Soviet Union are potential candidates for LNG projects. Some countries not included in this list might elect to expand existing projects depending upon the condi-

TABLE 3
Base-Load LNG Import Projects
(*Firm or Under Construction*)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Indonesia — U.S. North Sumatra — Little Cojo	1984	20	Pertamina — Mobil Pacific Lighting International S.A. Pacific Indonesia LNG Co. Western LNG Terminal Associates	550	2, France 1, France 6, U.S.	120,000 125,300 125,000
Algeria — Belgium Arzew — Zeebruge	1982	20	SONATRACH Distrigas, S.A.	500	1, Belgium 1, NA	131,600 125,000
Algeria — U.S. Arzew — Lake Charles, La.	1980	20	SONATRACH Trunkline Gas Co. Trunkline LNG Co.	450	2, U.S. 2, French 1, French	125,000 129,500 125,000
Algeria — France Arzew — Montoir de Bretague	1980	20	SONATRACH Gaz de France	515	1, French 1, NA	129,500 125,000
Malaysia — Japan Bintulu — Japanese Terminals	1983	20	Sarawak Petronas, Mitsubishi, Tokyo Gas, Osaka Gas, Tokyo Electric Power Co.	870	5, French	130,000
Algeria — Holland/Germany Arzew — Wilhelmshaven, Eemshaven	1983	20	SONATRACH Ruhrgas Ag. N.V. Nederlandse Gasunie Salzgitter Ferngas	1150	5, NA	125,000
Algeria — Germany Arzew — Wilhemshaven	1984	20	SONATRACH Thyssengas GmbH Gewerkschaft Brigitta	400	2, NA	125,000
Alaska — U.S. Kenai — Little Cojo	1985	20	Pacific Alaska LNG Associates Western LNG Terminal Associates	Initial: 200 Total: 400	1, U.S. 2, U.S.	130,000

TABLE 4
Base-Load LNG Import Projects
(*In Planning Stages*)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Indonesia — Japan East Kalimantan — Japanese Terminal (plant expansion)	1983	20	Pertamina Osaka Gas Co Toho Gas Kansai Electric Chuba Electric	435	3, NA	125,000
Chile — U.S. Cabo Negro — U.S.	1984	20	Chilean Gas Ltd. Atlantic Richfield Co. Air Products and Chemicals, Inc.	230	3, NA	125,000
Nigeria — U.S.	1985	25	Bonny LNG, Ltd. U.S. and European Customers	1600	16, NA	125,000
Arctic Islands — Canada	mid 1980's	20	Alberta Gas Trunkline Petro-Canada Southern Companies	250	2, NA	140,000
Australia — U.S., Japan	1985	NA	Woodside Group Japanese Customers	850	7-14, NA	125,000
Algeria — Germany	1985	20	SONATRACH Deutsche BP	450	2, NA	125,000
Indonesia — Japan Arun — Japanese Terminals (plant expansion)	1985	20	Pertamina Japanese Customers	220	1-2, NA	125,000

tions existing at that time. It is not yet possible to predict with any reasonable degree of certainty what the economic and energy situation in a particular country will be. One can only be reasonably certain that the time required to implement a project will not become shorter, and may even increase if more hostile environments are involved.

During this decade, projects in addition to those cited are not likely to be developed. Some of the projects cited will undoubtedly be added to the already existing list of those that have been cancelled or are held in abeyance.

Future Developments

Against this listing of projected development of LNG trade in the next decade, what background factors may exist?

Energy needs are going to increase, resulting in a return to a positive growth rate of perhaps 2%. Petroleum's share should maintain its 65% to 70% of primary energy supply.

Whether natural gas can increase its relative share depends upon economic and political considerations. Pipeline transport of gas costs roughly twice that for crude oil; the cost of sea transport for LNG is between four

TABLE 5

Base-Load LNG Import Projects
(Under Consideration)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Trinidad and Tobago — U S	1985	20	Trinidad and Tobago Peoples Overseas, Inc Tenneco Trinidad LNG	nominal 600	3, NA	130,000
U S S R — U S	1985-90	25	Occidental Petroleum Co El Paso LNG Co	1000	14, NA	125,000
U S S R — U S and France	1985-90	25	Brown and Root, Inc Tenneco, Inc Texas Eastern International Corp	1500 U S 500 France	20, NA	120,000
U S S R — Japan Nakhodka — Japan	1985-90	NA	Japanese Consortium	1000	4, NA	125,000
Qatar — Japan	1986	25	Shell Bridgestone	750	9, NA	125,000
Columbia — U S	1985	NA	Promigas Texaco	150	1, NA	40,000

TABLE 6

Base-Load LNG Import Projects
(Cancelled or Held in Abeyance)

Trade	Contract Initial Delivery	Contract Term, yr	Companies Involved	Daily Gas Volume, million cu ft	Number of Ships and Country of Construction	Capacity of Ships, cu m
Algeria — Sweden	1985	20	SONATRACH Swedegas	200	1, NA	125,000
Algeria — U S	1983	25	SONATRACH El Paso LNG Co El Paso Eastern Co	1000	12, NA	125,000
Algeria — Canada, U S	1983	20	SONATRACH Tenneco LNG, Inc. Lornetenn LNG Ltd	960	8, U S	125,000
Algeria — U S		20	SONATRACH EASCOGAS	600	3, U S 2, NA	125,000 125,000
Iran — Japan	1983	25	National Iranian Gas Co Japan Kalingas	400	5, Japan	125,000
Iran — U S	1983	25	National Iranian Gas Co Columbia LNG Corp Consolidated LNG	300	6, NA	125,000
Iran — Japan, Europe	1983	25	National Iranian Gas Co Japan Kalingas Chicago Bridge & Iron Co	400	6, NA	125,000

and five times that for crude oil. Pricing policies set by exporters and importers are obviously critical. They may be established so as to compensate for these economic disadvantages.

One effect of pricing policies may be to provide an incentive to export gas for countries with substantial non-associated reserves. Others may question the rationale of exporting gas, with its attendant capital-intensiveness and low employment per dollar of capital investment, to replace uses currently supplied by liquid petroleum products.

The importer or importing country will have to continue sharing in the capital costs and risks involved in developing LNG projects. This will be necessary to ensure the profitability of projects, especially for lesser-developed countries with large populations.

Over the next decade, projects are likely to continue to be developed on *long-term* contractual bases because of their massive capital requirements. The size of projects may show a broader spread in the future. More projects in the 300-to-500-million-cu-ft-per day range may be implemented because of uncertainties in long-term market needs. This would open up additional potential supply sources, make financing easier, and provide a measure of supply security.

To accommodate smaller projects, it appears reasonable to anticipate that modular facilities may be utilized. These facilities in various forms would speed construction, improve quality control, and reduce investment costs. The use of such facilities would be expected to have a positive effect on securing financing, since the risk of heavy financial charges for delayed commissioning and reduced reliability would be lessened.

In the 1980's, commercial projects involving liquefied gas at pressures significantly above ambient are expected to be developed. This would include those concepts proposed for small North Sea and Southeast Asian offshore fields. Such concepts, which have significant merits, must be evaluated as total systems.

Also anticipated for the 1980's is more extensive utilization of the refrigeration at LNG import terminals. Such cold utilization would have a favorable effect on overall project economics.

The LNG industry has reached early adulthood. Although its growth has not achieved projected levels originally, LNG remains a most viable industry. Future growth, at least for this decade, is expected to continue at a measured pace. In the late 1980's and early 1990's, when conventional supplies decline, perhaps there will be a period of more rapid project development. Certainly in this intervening period the LNG industry will have established the base necessary to support whatever level of future growth occurs. **P&GJ**

Profit Margins Are In Average Range

INCREASE IN PROFIT MARGIN from 4.8¢ to 5.9¢ on each dollar in sales is reported by 88 oil/natural gas companies for the year ending December 1979 compared to 1978. *Forbes* said "average returns for all U.S. industry for most recently reported 12-month period were 5.3¢ on sales." So oil companies' profit margins are in the "average" range as compared with all industries.

Higher prices and sales volumes of oil and natural gas accounted for earnings increases for Holly, Summit Energy, Texas Oil & Gas, Maynard, Diamond Shamrock, Callon Petroleum, Noble's Samedan, Sun, Triton Oil & Gas, Sohio and others.

Texaco said its U.S. earnings increase was due to improved refining/marketing activities compared with substantial losses in 1978. U.S. exploration/production results were up "due to higher prices for crude and natural gas as permitted by government price controls." Petrochemical earnings gained 77% over 1978 earnings.

Other international companies citing domestic earnings increases due to higher controlled prices of oil/gas are: Union California, Sun, Mobil, Pennzoil, Exxon, Atlantic Richfield, Cities Service.

Tenneco said gains in oil operations, with gains in six other major operating divisions accounted for Tenneco's record performance in 1979. Tenneco had 99% replacement of production by new reserves in 1978 and more than 100% in 1979.

Standard Indiana said overseas petroleum and worldwide chemical operations accounted for essentially all of the earnings gains in 1979. Overseas petroleum earnings were up 101% in 1979 over 1978; domestic petroleum earnings were down 8.7%.

For Conoco foreign operations gained 154%; U.S. petroleum operations rose 41%.

Marathon's foreign earnings were up 95%; U.S. net was up 16%; U.S. refining/marketing operations declined in 1979...Mobil's foreign energy earnings were up 132%; foreign earnings accounted for 81% of the worldwide energy earnings increase. U.S. energy earnings increased 39%, due to higher crude/natural gas prices.

Standard California said earnings gains were due to improved product prices worldwide, increased oil/gas production. Petroleum earnings in U.S. were up 38%; foreign petroleum earnings were up 78%.

FOURTH QUARTER GAS COMPANIES FINANCIAL REPORTS

	Three months ending December 31**						Twelve months ending December 31**					
	Revenues ($000)			Earnings* ($000)			Revenues ($000)			Earnings* ($000)		
Company	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.
Alabama Tennessee N.G.	19,838	7,991	+148.3	1,073	526	+104.0	69,878	37,446	+ 86.6	4,893	3,172	+ 54.3
American Natural Res.	797,528	590,154	+ 35.1	60,969	21,844	+179.1	2,505,622	2,096,532	+ 19.5	117,956	127,419	- 7.4
Arkansas Louisiana Gas	196,546	125,086	+ 57.1	8,738	9,482	- 7.8	735,302	530,218	+ 38.7	60,741	53,286	+ 14.0
Columbia Gas	872,689	656,349	+ 33.0	42,451	31,615	+ 34.3	2,851,733	2,444,171	+ 16.7	143,113	121,096	+ 18.2
Commonwealth Nat. Res.	47,566	32,657	+ 45.7	1,374	752	+ 82.7	154,318	118,170	+ 30.6	5,504	3,777	+ 45.7
Consolidated Nat. Gas	640,760	445,711	+ 43.8	39,213	26,508	+ 47.9	2,045,947	1,585,906	+ 29.0	128,303	114,640	+ 11.9
El Paso Companies	905,959	581,390	+ 55.8	27,647	36,766	- 24.8	3,088,556	2,030,636	+ 52.1	138,134	108,386	+ 27.4
Enserch Corp.	597,799	394,431	+ 51.6	21,200	6,700	+216.4	2,238,216	1,684,090	+ 32.9	84,500	56,300	+ 50.1
Houston Natural Gas[1]	561,371	352,584	+ 59.2	43,394	28,406	+ 52.8	2,006,622	1,536,003	+ 30.6	151,100	124,142	+ 21.7
Kansas-Nebraska N.G.	92,332	73,066	+ 26.4	7,154	3,635	+ 96.8	328,155	281,394	+ 16.6	19,653	18,578	+ 5.8
Mountain Fuel Supply							334,789	282,389	+ 18.6	23,875	20,061	+ 19.0
National Fuel Gas	188,751	151,504	+ 24.6	10,560	8,790	+ 20.1	653,957	556,397	+ 17.5	27,623	24,266	+ 13.8
Northern Natural Gas	775,687	538,757	+ 44.0	55,091	42,373	+ 30.0	2,449,202	1,981,988	+ 30.2	182,799	138,640	+ 31.9
Northwest Energy	384,879[2]	263,320[2]	+ 46.2	14,697[2]	10,218[2]	+ 43.8	1,119,532	819,982	+ 36.5	41,267	23,388	+ 76.4
Oklahoma Natural Gas	245,344[2]	185,326[2]	+ 32.4	4,584[2]	5,415[2]	- 15.3	735,879	642,501	+ 14.5	31,244	38,761	- 19.4
Pacific Lighting	703,085	475,281	+ 47.9	17,072	18,098	- 5.7	2,244,279	1,749,395	+ 28.3	92,071	73,777	+ 24.8
Panhandle Eastern	549,707	411,010	+ 33.7	23,814	39,100	- 39.1	1,967,657	1,410,957	+ 39.5	148,080	119,211	+ 24.2
Peoples Energy Corp.	752,690	572,963	+ 31.4	39,674	37,886	+ 4.7	2,621,284	2,015,913	+ 30.0	142,076	129,849	+ 9.4
Pioneer Corp.	200,248	128,028	+ 56.4	17,016	4,679	+ 63.6	732,486	556,012	+ 31.7	65,631	34,000	+ 93.0
Southern Nat. Res.	431,644	306,469	+ 40.8	25,917	25,284	+ 2.5	1,492,222	1,105,037	+ 35.0	109,415	103,422	+ 5.8
Texas Eastern Corp.	874,611	579,666	+ 50.9	50,357	35,130	+ 43.3	2,944,168	2,027,598	+ 45.2	180,551	137,206	+ 31.6
Texas Gas Transmission	498,404	343,986	+ 44.9	26,618	18,593	+ 43.2	1,686,560	1,214,411	+ 38.9	79,022	60,394	+ 30.8
TransCanada PipeLines							2,580,972	2,193,213	+ 17.7	87,168	87,926	- 1.0
Transco Companies	468,944	283,869	+ 65.2	22,384	13,265	+ 68.7	1,528,108	953,768	+ 60.2	68,361	55,881	+ 22.3
Union Gas Ltd.	195,988	172,616	+ 13.5	3,525	6,075	- 42.0	667,727	640,708	+ 4.2	16,978	22,295	- 23.8
United Energy Res.	957,788	503,760	+ 90.1	28,380	16,953	+ 67.4	2,133,654	1,992,183	+ 7.1	111,687	82,393	+ 35.6
Westcoast Transmission							1,100,000	844,000	+ 30.3	49,900	44,900	+ 11.1
TOTALS	11,960,158	8,175,974	+ 46.3	592,902	448,093	+ 32.3	41,210,865	33,331,018	+ 23.6	2,311,645	1,927,166	+ 20.0

**Excluding non-recurring items. *Earnings available to common stock. [1] Ends October 31. [2] Four months.

Exxon's refining/marketing component of U.S. earnings was down 62% from 1978 earnings...Marion's refinery was shut down for 5 days from hurricane damage, which adversely affected its third quarter results...Gulf also had fourth quarter "downstream" earnings decline because of "rapidly escalating foreign crude costs that were not passed on in the market place."

Diamond Shamrock's gains are attributed to new catalytic cracking capacity, increases in production of crude and natural gas and favorable natural gas liquids prices...Tomlinson acquired new production and had better earnings from increased oil/gas sales and refined product sales.

Quaker State said "improved earnings for 1979 ware attributed primarily to a turnaround in coal operations." Other companies with increased coal earnings were Diamond Shamrock, Conoco and Mapco. Patrick Petroleum said its coal revenues were up 122%. R.L. Burns had 71% increase in coal sales.

Coal operations declined for Triton Oil & Gas. Gulf reported losses in its nuclear operations.

Pacific Lighting's earnings came almost entirely from non-utility operations; real estate made up the major part of its non-utility results.

Growing oil/gas exploration/production and profitable liquids extraction together provided 79% of operating income for Pioneer Corp.

Greater availability of natural gas was cited by Alabama Tennessee N.G., Transco Cos., and Commonwealth Natural Resources for increases in earnings.

Northern Natural Gas' liquid fuels and petrochemical groups contributed 52% to its earnings. Exploration/production division had its best year in 1979; natural gas earnings declined 12% from 1978 levels; coal operations have not yet contributed to Northern's earnings.

Houston Natural's oil/gas exploration/production division reported substantial increases in sales for the quarter ending Oct. 31. Exploration activities for the period resulted in the discovery of more natural gas than was produced.

Oil/gas exploration/production division of Texas Gas Transmission contributed $196.1 million in revenues to the $1.7 billion total.

Circle 4 on Reader Service Card

FOURTH QUARTER OIL COMPANIES FINANCIAL REPORTS

	Three months ending December 31**						Twelve months ending December 31**							
	Revenues ($000)			Earnings* ($000)			Revenues ($000)			Earnings* ($000)			Profit Margin‡	
Company	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978	% Chg.	1979	1978
1.Adams Res. & Energy	54,443	28,658	+ 90.0	740	635	+ 16.5	178,893	103,634	+ 72.6	4,439	3,046[a]	+ 45.7	2.5	2.9
2.Altex Oil	213	158	+ 34.8	48	(103)		679[b]	957[b]	- 29.0	(188)[b]	116[b]		none	12.1
3.Amarex[c]	3,905	2,674	+ 46.0	786	620	+ 26.8	11,741[d]	8,354[d]	+ 40.5	2,938[d]	2,556[d]	+ 14.9	25.0	30.6
4.Ancole Energy	465	700	- 33.6	(155)	(241)		888[e]	1,880[e]	- 52.8	(247)[e]	(213)[e]		none	none
5.Amerada Hess	2,123,725	1,214,809	+ 74.8	118,897	38,181	+211.4	6,813,201	4,739,502	+ 43.7	507,116	138,898	+265.1	7.4	2.9
6.Am. Petrofina	492,897	328,621	+ 50.0	17,707	20,391	- 13.2	1,622,575	1,173,799	+ 38.2	83,187	32,351	+157.1	5.1	2.8
7.Arapaho Petr.[f]	2,907	3,514	- 17.3	169	106	+ 59.4	3,927[e]	4,122[e]	- 4.7	203[e]	93[e]	+118.3	5.2	2.3
8.Argonaut Energy	742	503	+ 47.5	151	6	+2416.6	1,996[d]	1,336[d]	+ 46.1	111[d]	34[d]	+226.4	5.6	2.5
§ 9.Ashland Oil[b]	1,990,285	1,484,911	+ 34.0	57,420	48,304	+ 18.9	7,245,737	5,601,458	+ 29.4	185,359	159,400	+ 16.3	2.6	2.8
10.Asamera	72,605	41,900	+ 73.3	1,907	1,356	+ 40.6	191,481[d]	126,171[d]	+ 51.8	8,517[d]	2,940[d]	+189.7	4.4	2.3
§11.Atlantic Rich.	5,049,617	3,270,071	+ 54.4	342,958	222,574	+ 54.1	16,676,677	12,738,809	+ 30.9	1,165,894	804,325	+ 45.0	7.0	6.3
12.Brock Expl.	1,631	830	+ 96.5	428	221	+ 93.7	3,821[d]	2,160[d]	+ 76.9	896[d]	684[d]	+ 31.0	23.5	31.7
13.R.L. Burns[c]	22,511	12,409	+ 81.4	(2,535)	(2,543)								none	none
14.Callon Petr.[f]	1,986	1,128	+ 76.1	621	218	+184.9	3,689[e]	2,430[e]	+ 51.8	993[e]	536[e]	+ 85.3	26.9	22.1
15.Centura Energy	5,648	3,690	+ 53.1	184	140	+ 31.4	7,731[e]	5,063[e]	+ 52.7	64[e]	(33)[e]		0.8	none
16.Cities Service	1,804,200	1,229,400	+ 46.8	106,200	(30,300)		6,276,700	4,660,900	+ 34.7	347,500	118,000	+194.5	5.5	2.5
17.Clark O&R	332,017	265,947	+ 24.8	16,070	8,954	+ 79.5	1,175,016	968,585	+ 21.3	44,558	14,541	+206.4	3.8	1.5
18.Consolidated O&G	12,883	7,069	+ 82.2	1,696	390	+334.9	37,035	26,105	+ 41.9	2,151	45	+4680.0	5.8	0.2
§19.Conoco Inc.	3,795,700	2,829,700	+ 34.1	190,700	155,200	+ 22.9	13,082,900	9,871,800	+ 32.5	815,400	451,300	+ 80.7	6.2	4.6
20.Damson Oil	6,558	3,911	+ 67.7	585	226	+158.8							8.9	5.8
21.Diamond Shamrock	666,129	475,398	+ 40.1	58,507	46,178	+ 26.7	2,351,606	1,817,983	+ 29.4	178,123	139,132	+ 28.0	7.6	7.7
22.Dorchester Gas[f]	143,647	69,454	+106.6	8,750	4,059	+115.6							6.1	5.8
§23.Earth Resources[f]	132,794	92,840	+ 43.0	6,699	3,276	+104.4	446,199	384,725	+ 16.0	19,910	11,886	+ 67.5	4.4	3.1
24.Energy Minerals	2,503	1,816	+ 37.8	878	610	+ 43.9	7,002[d]	4,892[d]	+ 43.1	2,126[d]	1,825[d]	+ 16.5	30.4	37.3
25.Energy Sources[c]							1,953	2,981	- 34.5	(27)	(300)		none	none
26.Exxon	24,074,000	17,308,000	+ 39.1	1,365,000	853,000	+ 60.0	79,981,000	61,325,000	+ 30.4	4,295,000	2,763,000	+ 55.4	5.4	4.5
27.Galaxy Oil[f]	2,151	1,786	+ 20.4	62	131	- 52.7	6,037[g]	5,904[g]	+ 2.3	1,384[g]	(312)[g]		22.9	none
28.General American	57,117	37,190	+ 53.6	15,492	9,162	+ 69.1	108,749[e]	71,382[e]	+ 52.3	27,227[e]	15,779[e]	+ 72.6	25.0	22.1
§29.Getty Oil	1,546,526	1,033,215	+ 49.7	182,590	101,546	+ 79.8	5,120,739	3,758,148	+ 36.3	604,434	330,087	+ 83.1	11.8	8.8
30.Great Basins[c]	6,010	6,199	- 3.0	(1,638)	547								none	8.8
31.Gulf E&D	24,726	6,058	+308.2	2,117	583	+263.1	54,589	20,227	+170.0	5,552	2,222	+150.0	10.2	11.0
§32.Gulf Oil Corp.	7,727,000	5,446,000	+ 41.9	366,000	237,000	+ 54.4	26,137,000	20,094,000	+ 30.1	1,322,000	785,000	+ 68.4	5.1	3.9
33.Helmerich & Payne	46,862	36,612	+ 28.0	10,452	8,144	+ 28.3							21.2	19.2
34.Holly Corp.[c]	100,719	71,949	+ 40.0	2,898	2,217	+ 30.7							2.9	3.1
35.Inexco Oil	29,348	16,092	+ 82.4	5,372	2,193	+145.0	102,677	71,605	+ 43.4	17,504	10,316	+ 69.7	17.1	14.4
36.Intercontinental	1,705	4,197	- 59.4	(405)	586		19,979[b]	5,594[b]	+ 96.3	4,536[b]	(2,528)[b]		41.3	none
37.Kerr-McGee Corp.	755,470	543,542	+ 39.0	40,396	40,023	+ 0.9	2,683,469	2,072,443	+ 29.5	160,017	118,196	+ 35.4	6.0	5.7
38.Lear Petr.	22,858	18,001	+ 27.0	1,760	922	+ 90.9	83,172	61,725	+ 34.7	5,845	3,560	+ 64.2	7.0	5.8
39.Louisiana L&E	246,352	144,601	+ 70.4	44,313	22,949	+ 93.1	817,014	549,416	+ 48.7	169,044	94,778	+ 78.4	20.7	17.3
40.Mapco	305,558	169,178	+ 80.6	24,251	21,971	+ 10.4	857,912	571,815	+ 50.0	72,113	60,784	+ 18.6	8.4	10.6
§41.Marathon	2,220,287	1,372,160	+ 61.8	54,261	73,867	- 26.5	7,199,522	4,954,710	+ 45.3	323,222	225,169	+ 43.5	4.5	4.5
42.Marion[c]	75,143	50,350	+ 49.2	5,660	1,811	+212.5	224,533	134,775	+ 66.6	14,380	5,431	+164.8	6.4	4.0
43.Maynard[f]	5,935	3,742	+ 58.6	820	281	+191.8	10,231[e]	7,879[e]	+ 29.9	1,141[e]	615[e]	+ 85.5	11.2	7.8
44.McMoRan O&G	10,062	4,957	+103.0	874	13	+6623.1	17,643	9,723	+ 85.1	1,750	550	+218.2	9.9	5.7
45.Mesa Petroleum	87,499	45,654	+ 91.7	16,361	11,524	+ 42.0	269,420	166,517	+ 61.8	54,203	41,766	+ 29.8	20.1	25.1
46.Mitchell Energy[h]	116,974	69,478	+ 68.4	11,885	7,605	+ 56.3	304,393[d]	196,781[d]	+ 54.7	31,907[d]	25,078[d]	+ 27.2	10.5	12.7
§47.Mobil Corp.	14,490,000	10,681,000	+ 35.7	541,000	315,000	+ 71.7	47,941,000	37,331,000	+ 28.4	2,010,000	1,131,000	+ 77.7	4.2	3.0
48.Murphy Oil	411,363	303,498	+ 35.5	38,007	17,382	+118.7	1,590,384	1,217,689	+ 30.6	103,567	46,589	+122.3	6.5	3.8
49.Natomas	283,403	230,579	+ 22.9	34,182	13,112	+260.7	1,010,208	882,674	+ 14.4	110,788	62,334	+ 77.7	11.0	7.1
50.Noble Affiliates	61,942	47,206	+ 31.2	10,913	5,500	+ 98.4	213,838	176,221	+ 21.3	33,041	24,710	+ 33.7	15.5	14.0
51.Ocean O&G	18,792	10,358	+ 81.4	3,539	574	+516.6	58,354	32,741	+ 78.2	9,363	2,593	+261.1	16.0	7.9
52.Pacific Resources	172,315	133,155	+ 29.4	3,805	2,845	+ 33.7	554,068	471,679	+ 17.4	13,722	9,268	+ 48.1	2.5	2.0
53.Patrick Petr.[c]	8,807	10,566	- 16.6	(740)	1,063	-169.6	37,863	28,197	+ 34.2	(108)	2,065	-105.2	none	7.3
54.Patton Oil	857	209	+310.0	221	(245)		1,928[d]	663[d]	+190.8	457[d]	(280)[d]		23.7	none
55.Pauley Petr.[f]	42,850	24,216	+ 76.9	3,145	140	+2146.4							7.3	0.6
56.Pennzoil Co.	603,064	447,706	+ 34.7	72,008	41,881	+ 71.9	2,051,693	1,553,108	+ 32.1	233,789	123,170	+ 89.8	11.4	7.9
57.Petro-Lewis	25,271	11,556	+118.7	4,155	1,070	+288.3							16.4	9.3
58.Phillips Petr.	3,044,789	2,200,002	+ 38.4	306,491	279,539	+ 9.6	9,744,750	7,421,942	+ 31.3	891,121	718,117	+ 24.1	9.1	9.7
59.Premier Res.	1,262	924	+ 36.6	398	15	+2553.3	4,364[b]	4,085[b]	+ 6.8	195[b]	715[b]	- 72.7	4.5	17.5
60.Presidio Oil Co.	1,042	506	+105.9	54	19	+184.2	3,385	2,277	+ 48.7	86	143	- 39.9	2.5	6.3
61.Quaker State	178,494	130,431	+ 36.8	5,064	6,774	- 25.2	691,641	513,188	+ 34.8	34,121	25,345	+ 34.6	4.9	4.9
62.Sabine Corp.	25,684	13,909	+ 84.7	5,258	1,308	+302.0	84,295	54,631	+ 54.3	14,561	7,183	+102.7	17.3	13.1
63.Seneca Oil[b]	897	511	+ 75.5	33	38	- 13.2	2,587	1,608	+ 60.9	70	184	- 62.0	2.7	11.4
64.Shell Oil	4,301,300	2,923,600	+ 47.1	331,200	192,300	+ 72.2	14,546,200	11,123,000	+ 30.7	1,125,600	813,600	+ 38.3	7.7	7.3
65.Southland Royalty	76,230	45,372	+ 68.0	16,962	10,013	+ 69.4	256,611	183,553	+ 39.8	54,752	42,540	+ 28.7	21.3	23.2
§66.Standard Cal.	9,806,000	6,835,000	+ 43.5	524,000	316,000	+ 65.8	31,775,000	24,597,000	+ 29.2	1,785,000	1,089,000	+ 63.9	5.6	4.4
§67.Standard Indiana	6,069,900	4,298,700	+ 41.2	368,700	216,700	+ 70.1	20,215,300	16,349,800	+ 23.6	1,506,600	1,076,400	+ 40.0	7.5	6.6
68.Standard Ohio	2,349,700	1,540,400	+ 52.5	451,000	164,500	+174.2	7,916,000	5,197,700	+ 52.3	1,186,100	450,200	+163.5	15.0	8.7
69.Statex Petr.[c]							4,224	3,978	+ 6.2	787	695	+ 13.2	18.6	17.5
70.Summit Energy[c]	1,257	1,182	+ 6.3	530	642	- 17.4	4,067[i]	3,912[i]	+ 4.0	1,704[i]	1,939[i]	- 12.1	41.9	49.6
71.Sun Co.	3,200,000	2,100,000	+ 52.4	222,900	107,600	+107.2	10,800,000	7,600,000	+ 42.1	699,900	414,700	+ 68.8	6.5	5.5
72.Superior Oil	306,566	215,911	+ 42.0	47,682	17,162	+177.8	1,085,394	730,942	+ 48.5	200,287	87,511	+128.9	18.5	12.0
73.Supron Energy	14,053	9,540	+ 47.3	4,796	2,658	+ 80.4	48,142	35,560	+ 35.3	14,454	10,003	+ 44.5	30.0	28.1
74.Tenneco	3,306,000	2,484,000	+ 33.1	157,000	123,000	+ 27.6	11,337,000	8,877,000	+ 27.9	539,000	421,000	+ 28.0	4.8	4.7
75.Tesoro[b]	1,032,191	323,139	+219.4	34,359	10,672	+222.0	3,107,500	1,315,000	+136.3	72,100	31,100	+131.8	2.3	2.4
76.Texaco Inc.	12,013,000	8,264,000	+ 45.4	533,929	328,261	+ 62.7	39,096,000	29,124,000	+ 34.2	1,759,069	852,461	+106.4	4.5	2.9
77.Texas O&G[f]	267,740	167,105	+ 60.2	29,259	19,270	+ 51.8	899,497[j]	712,293[j]	+ 26.3	97,277[j]	76,534[j]	+ 27.1	10.8	10.7
78.Tipperary Corp.	19,348	11,130	+ 73.8	2,066	359	+475.5	66,685	47,086	+ 41.6	2,997	(3,661)		4.5	none
79.Tomlinson[f]	13,697	6,441	+112.7	1,522	313	+386.3							11.1	4.9
80.Tosco Corp.	549,185	318,025	+ 72.7	24,556	6,011	+308.5	1,922,237	1,165,697	+ 64.9	78,028	18,033	+332.7	6.7	1.6
81.Total Petr. N.A.	279,463	175,495	+ 59.2	11,426	6,505	+ 75.6	910,505	572,310	+ 59.1	29,871	14,416	+107.2	3.3	2.5
82.Triton O&G[f]	4,195	4,000	+ 4.9	566	66	+757.6	7,363	7,638	- 3.6	639	246	+159.8	8.7	3.2
83.Union Calif.	2,213,400	1,676,200	+ 32.0	152,300	123,800	+ 23.0	7,679,100	6,105,100	+ 25.8	500,600	382,300	+ 30.9	6.6	6.3
84.United Refining	150,349	103,108	+ 45.8	4,166	2,698	+ 54.4	[illegible]	369,074	+ 36.3	15,281	7,831	+ 95.1	3.0	2.1
§85.Universal Res.[c]	8,881	5,635	+ 57.6	1,292	731	+ 76.7	26,461	21,426	+ 23.5	3,124	3,652	- 14.5	11.8	17.0
86.Vanderbilt Energy[b]	1,130	1,145	- 1.3	243	89	+173.0	3,730	4,762	- 21.7	503	440	+ 14.3	13.5	9.2
87.Westcoast Petr.							32,214	26,187	+ 23.0	8,606	7,731	+ 11.3	26.7	29.5
88.Williams Cos.	460,100	340,628	+ 35.1	23,423	(566)		1,850,013	1,497,008	+ 23.6	69,450	27,684	+150.9	3.8	1.8
TOTAL	119,996,830	83,855,160	+ 43.1	7,049,342	4,249,332	+ 65.9	398,213,046	301,687,019	+ 32.0	23,686,784	14,340,144	+ 65.2	5.9	4.8

**Excluding non-recurring items. *Earnings available to common stock. ‡Earnings* divided by Revenues = Profit Margin. () Loss. §Revenues include excise taxes. [a]Ends March 31. [b]Ends Sept. 30. [c]Ends Oct. 31. [d]Nine months. [e]Six months. [f]Ends Nov. 30. [g]Ends May 31. [h]Ends Jan. 31. [i]Ends July 31. [j]Ends Aug. 31.

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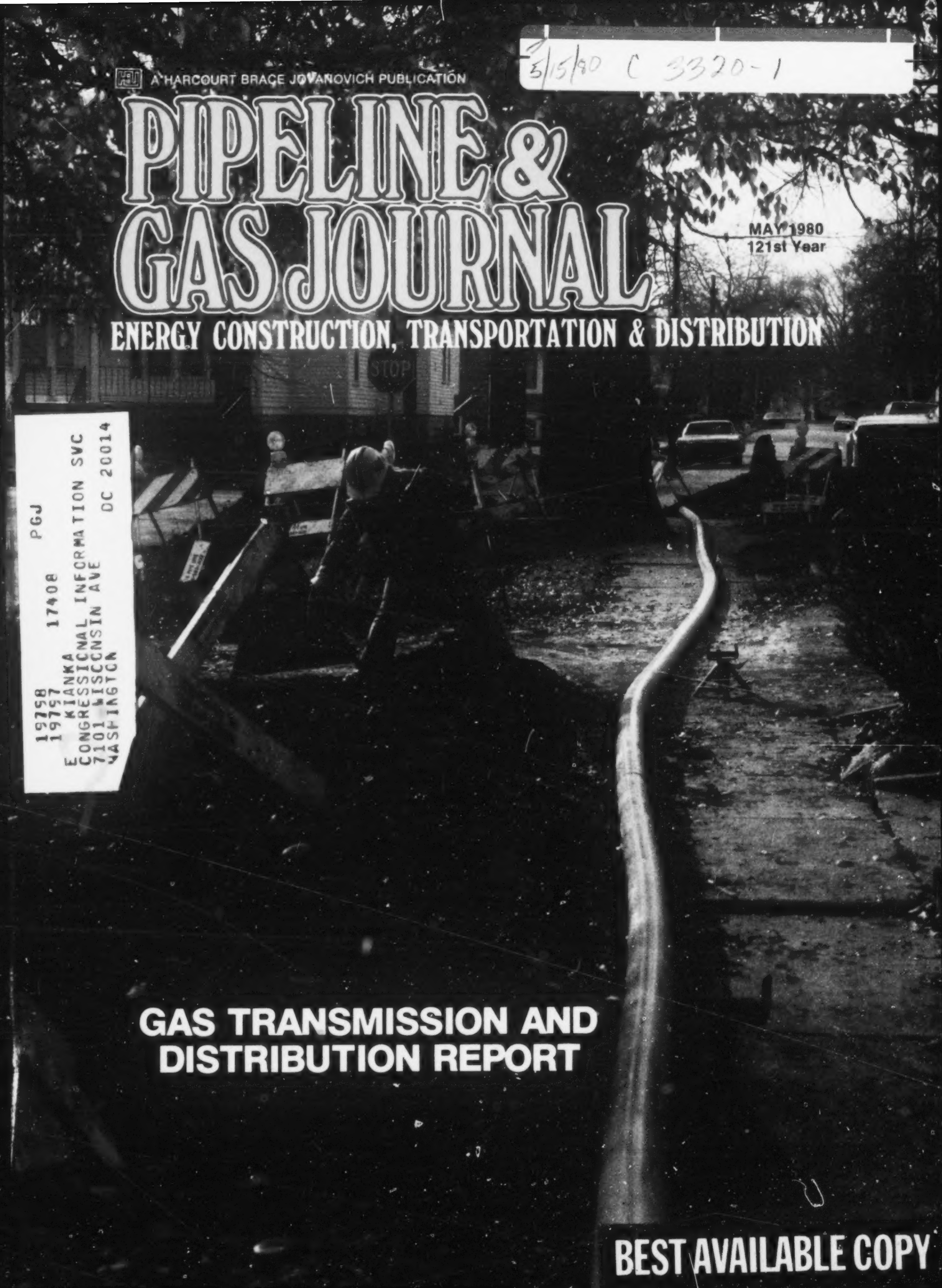

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THE COVER
Primary concern is given customer service by Wisconsin Power & Light Co. when gas distribution system upgrading projects are undertaken; crews begin lawn, sidewalk, and street restoration immediately after completing underground work.

— Courtesy Wisconsin Power & Light Company

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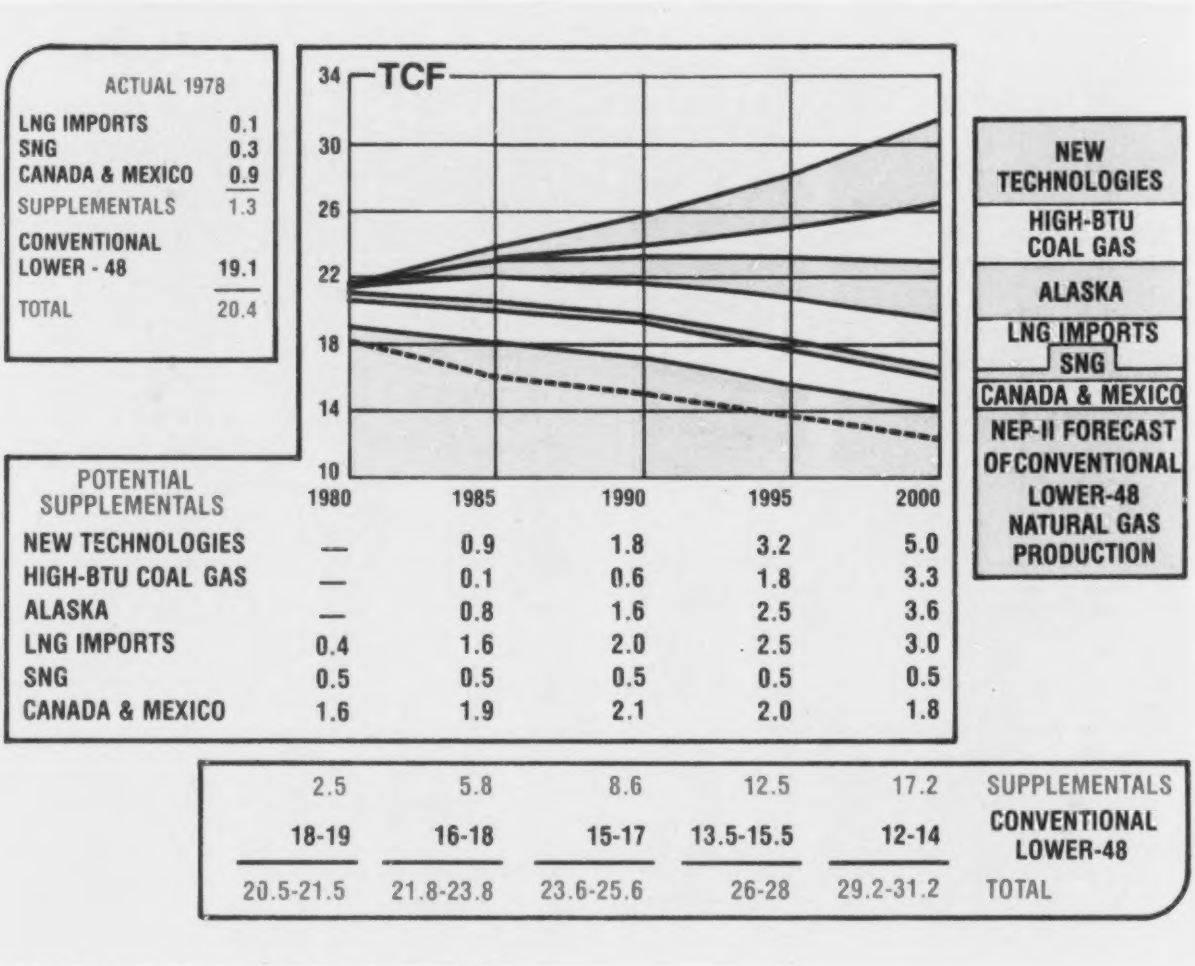


ACTUAL 1978	
LNG IMPORTS	0.1
SNG	0.3
CANADA & MEXICO	0.9
SUPPLEMENTALS	1.3
CONVENTIONAL LOWER - 48	19.1
TOTAL	20.4

POTENTIAL SUPPLEMENTALS	1980	1985	1990	1995	2000
NEW TECHNOLOGIES	—	0.9	1.8	3.2	5.0
HIGH-BTU COAL GAS	—	0.1	0.6	1.8	3.3
ALASKA	—	0.8	1.6	2.5	3.6
LNG IMPORTS	0.4	1.6	2.0	2.5	3.0
SNG	0.5	0.5	0.5	0.5	0.5
CANADA & MEXICO	1.6	1.9	2.1	2.0	1.8

1980	1985	1990	1995	2000	
2.5	5.8	8.6	12.5	17.2	SUPPLEMENTALS
18-19	16-18	15-17	13.5-15.5	12-14	CONVENTIONAL LOWER-48
20.5-21.5	21.8-23.8	23.6-25.6	26-28	29.2-31.2	TOTAL

Summary of potential gas supplies through the year 2000.

Future Gas Supply, Demand, Construction Solid

by **George H. Lawrence,** *President, American Gas Association, Arlington, Virginia*

America's gas industry is moving into the 1980s on a solid and optimistic footing. Terms such as *renaissance, revival, resurgence,* and *optimism* are commonly used among those inside the industry to describe the current prospects for gas energy, both now and in the future.

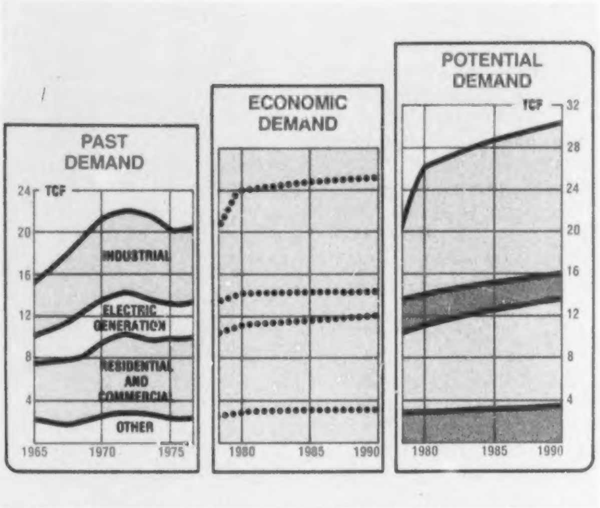
These positive words come from a variety of respected sources, many of them in the financial community, whose support will be vital to the gas industry's future. Merrill Lynch, Salomon Brothers, First Boston, and Morgan Stanley all have issued optimistic reports strongly supporting the gas energy option. Recent additions to the list include Argus Research Corporation and Lehman Brothers Kuhn Loeb Research.

A February 13 *Wall Street Journal* article quoted Foster Corwith of Argus as saying "Natural gas appears to be well positioned to supply a significant portion of the country's long-term incremental energy needs." The article detailed the "Bright Outlook" for gas stocks.

In a January 8 "Industry Review" report, Edward I. Lefferman of Lehman Brothers concluded that "In sum, the developments in recent months reinforce our conviction that the industries involved in natural gas face a bright fundamental outlook."

An August, 1979 report by Morgan Stanley and Co. was equally positive. Under the title "Natural Gas: Renaissance of an Industry," the company's analysts cited a number of reasons for the gas industry's resurgence:

- Passage of the Natural Gas Policy Act (NGPA) in November, 1978, which eliminated economic barriers to greater gas sales by allowing intrastate gas to move into the interstate market.
- A significant increase in the search for new gas reserves by independent and major exploration companies;



Potential gas demand through 1990. Economic demand (middle chart) is based on price and technology alone, not constrained by regulations, misperceptions of short supply, and other restraints. Potential demand reflects continuing environmental restrictions on coal use and federal policy discouraging oil imports.

- Economic attraction of gas as compared to higher-priced fuels;
- Reversal in government policies which had discouraged the use of natural gas; and
- Reinforcement of the environmental advantages of gas.

The report points out the importance of, and opportunities for, the gas industry to increase supplies in order to meet future demand: "The possibility of increased gas demand exists in every market. Until only recently, however, producers' and distributors' desires to serve that demand were stymied by an environment that discouraged additional production and expanding markets. Promoting that incremental supply is imperative if the industry is to keep pace with demand. Maintaining current production levels will provide a challenge to the industry."

Major Expenditures Planned

This is a challenge the gas industry is meeting in many different ways.

Among these are major expenditures for utility maintenance and construction, equipment maintenance and acquisition, and pipeline maintenance and construction. The gas industry will spend a total of more than $300 billion (1978 dollars) between 1979 and 2000 for utility and pipeline construction.

Forecasts for construction budgets indicate that annual expenditures will be in the $5 billion dollar range for the next two to three years. This compares to budgets of only about $2 billion during the recent 1975-1977 period.

The nation's gas delivery system – transmission pipelines and distribution mains – is itself an invaluable national resource. It is the most extensive and most dependable energy delivery system in the nation, covering over a million miles. From present underground gas storage facilities connected to the system the industry can deliver the gas equivalent of a billion barrels of crude oil.

Over $2 billion annually is forecast for 1981 and again in 1982 for distribution construction alone. Of the nearly 9,000 miles of pipeline built in the U.S. last year, about 60% was for natural gas projects. Much of this consisted of projects involving pipe larger than 20-in.

On the conventional supply front, gas well completions last year scored an impressive 13% overall gain over 1978, possibly reaching the highest level in history. Seismic activity also reached a twenty year high level, a positive indicator for future drilling activities. Deregulation of wellhead prices for "deep gas" (below 15,000 ft) has resulted in a 10% ncrease in well completions in the areas of deep drilling, a ategory that the Potential Gas Committee thinks may hold 20% of all potential gas supplies.

Offshore exploration is another area of high potential and offshore gas well completions increased by 10% in 1979. An increase of approximately 34% occurred in oil and gas drilling on the Western Overthrust Belt, while price deregulation of Devonian Shale Gas contributed to a 20% increase for gas well completions in the Appalachian Basin.

There are between 35 and 60 years of recoverable conventional gas supplies remaining to be produced in the U.S. at our present rate of consumption. In addition, the resources contained in other, unconventional gas formations – geopressurized methane, gas from Devonian Shale and tight sands, methane from coal seams – far exceed conventional sources, and are practically unlimited.

To meet the growing demand for gas energy, a substantial contribution will come from supplemental sources. A number of agreements and regulatory decisions in recent months have greatly improved the outlook for gas energy from these sources.

Final approval has been granted for construction of an LNG facility at Point Conception, Calif. which will receive and regasify Alaskan and Indonesian LNG. The U.S. could be importing two trillion cubic feet (Tcf) of LNG per year by the end of this decade and as much as three Tcf by 2000. Significant environmental, employment, price and balance of payments advantages exist for LNG over imported oil.

About The Author

George H. (Bud) Lawrence, *president of the American Gas Association, is a petroleum engineer and attorney in the natural gas and petroleum industries with 30 years' experience.*

Lawrence has been with A.G.A., the national industry association for natural gas distribution and transmission companies, since July 1968. He joined A.G.A. as manager of the Washington office when the association headquarters was in New York City, served successively in a number of key positions after A.G.A. moved to Arlington, Va., in 1970, and assumed the presidency of A.G.A. on November 1, 1976.

From 1949 to late 1959, he was petroleum engineer in the Production Department of Humble Oil and Refining Company, Houston, Texas (now EXXON U.S.A.), and then as an attorney for Humble specializing in natural gas and Federal Power Commission matters until early 1962, when he moved to Humble's Natural Gas Division at the assistant manager level. In May 1963, he entered the private practice of law and was a petroleum engineering consultant in Houston. From late 1964 to July 1968, he was with the American Petroleum Institute in Washington, D.C. as Natural Gas Coordinator.

Lawrence, a native of Bartlesville, Oklahoma, received a B.S. degree in Industrial Engineering in 1949 from Oklahoma State University and an L.L.B. degree from South Texas College of Law, Houston, in 1957.

He is a registered professional engineer in the State of Texas, and a member of the American Bar Association; Texas Bar, and Federal Energy Bar Association. He serves on several boards of directors including the National Energy Foundation, the Council for Urban Environmental Studies, and the Ford's Theater Society.

Lawrence most recently was accorded honors by the National Energy Resources Organization (NERO), which awarded him a 1980 Energy Merit Award for distinguished service in contributing to the nation's energy problems in 1979.

Last year's agreement to import Mexican gas, coupled with a greater flow of Canadian gas, was a positive step in the supplemental area. Financing arrangements for the Alaskan natural gas pipeline are also progressing. Alaska has 31.6 Tcf of proven reserves that, when added to the Potential Gas Committee's resource estimates, totals over 200 Tcf, or 10 times the amount of gas the U.S. consumes annually. By the mid 1980s, residents of the West Coast and Midwest could be using Alaskan gas.

The gas industry is on the brink of a whole new chapter in the gas supply story. This first step in producing vast new quantities of gas from America's enormous reserves of coal has been taken. The Federal Energy Regulatory Commission (FERC) has approved plans for building the nation's first commercial-sized coal gasification plant in Mercer County, N. Dak. The Great Plains Coal Gasification project is intended to demonstrate the economic feasibility of building these plants and to show the major contribution a coal gas industry can make toward meeting future energy needs.

Many new and promising future technologies for producing gas energy constitute another source of confidence in the gas industry's future. Among these are gas from land and marine biomass, gas from organic and municipal wastes, peat gasification, gas hydrates, and hydrogen. These and other technologies, perhaps as yet undiscovered, underscore the possibility that the future for gas energy may in fact be virtually limitless. Research and development have had and will continue to have a very high priority in this country's gas industry.

A positive future for gas supply obviously is good news for an industry expecting a 25% increase in demand to about 25 to 28 Tcf per year by 1990 – less than 10 years from now. This demand for gas in traditional markets – residential, industrial, commercial – will be even greater if there are increased government restrictions on importing oil and if strict environmental laws are maintained or stiffened. Additional demands could come from nontraditional markets such as automotive fleet fueling, gas cooling and air conditioning, and gas burned alternately with coal at problem pollution times.

Demand also will be accelerated by customer growth. The staggering increases in the cost of imported oil refined into home heating oil has caused a sharp increase in demand for residential oil-to-gas conversions. Many gas utilities are receiving more than 1000 requests per month for space heating service.

Customer growth for 1980 is expected to exceed the highest growth experienced in the last 30 years. The American Gas Association estimates that 225,000 homeowners converted from oil to gas in 1979, a 57% increase over 1978. And 550,000 new homes installed gas heat.

With A.G.A. projections indicating gas will retain its price advantage over oil and electricity for house heating until 1990 and beyond, the residential market demand is unlikely to diminish.

The U.S. Department of Energy's announced policy of doing everything possible to reduce oil imports includes encouraging some industries to switch from oil to gas, further stimulating demand for gas. Last year natural gas displaced oil at a rate of 435,000 bbl per day in industrial energy markets for an estimated savings of $4 billion in foreign oil payments.

A continuing supply of gas energy for the pipeline today and far into the future is the gas industry's goal. The demands for gas energy and its delivery system are expected to grow rather than shrink. Fortunately, the 1980 prognosis for meeting this demand is excellent. The "Gas Option" will play an important role in America's energy picture. **P&GJ**

Nearly 350,000 Miles of Pipe, Over $70-Billion Expenditures Projected For 1980's

Growth pattern of the U.S. gas industry in terms of piping installed and expenditures for construction of that piping has been projected by PIPELINE & GAS JOURNAL's market research group for the 10-year period of 1980 through 1989.

As shown in the table below, the gas industry in aggregate will install 349,792 miles of new pipe – as cross-country transmission pipelines, field and gathering lines, gas mains, and gas services – during the 10-year period.

Expenditures for the decade will total a projected $70.154 billion, of which $10.8 billion has been allocated to the Alaskan and Lower 48 States portions of the Alaska Highway Gas Pipeline Project during the 1981 through 1989 period. (Cost increases for this project beyond the $10.8 billion figure have not been included.) The projection assumes that the project will officially get underway sometime in late 1980 or early 1981.

Gas distribution growth figures are predicated on continuing expansion in the number of residential, commercial, and industrial customers, plus replacement of outdated facilities to meet new customer demands and to meet system standards dictated by federal and state regulatory agencies.

U.S. GAS INDUSTRY PIPING FORECAST — 1980-1989

Projection	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Miles of Gas Pipeline	4,246	4,350	4,500	4,800	4,250	4,000	4,200	4,100	4,300	4,050
Miles of Gas Gathering & Field Lines Installed	1,200	1,350	1,400	1,400	1,300	1,300	1,300	1,250	1,200	1,350
Total Miles of Gas Pipelines Installed	5,446	5,700	5,900	6,200	5,550	5,300	5,500	5,350	5,500	5,400
Miles of Gas Mains Installed	13,448	14,000	14,900	14,800	14,400	14,600	14,200	14,200	14,700	15,100
Miles of Gas Services Installed	13,798	14,000	14,200	14,600	14,700	15,000	15,600	15,500	15,900	15,900
Total Miles, All Gas Industry Piping Installed	**32,692**	**33,700**	**35,000**	**35,600**	**34,650**	**34,900**	**35,700**	**35,050**	**36,100**	**36,400**
Construction Expenditures, $Billion, Pipeline	1.381	4.318	4.825	5.317	4.143	3.073	2.930	3.135	3.546	3.829
Construction Expenditures, $Billion, Distribution	1.781	2.049	2.381	2.646	2.987	3.402	3.870	4.299	4.872	5.370
Total Construction Expenditures, $Billion	**3.162**	**6.367**	**7.206**	**7.963**	**7.130**	**6.475**	**6.800**	**7.434**	**8.418**	**9.199**

Source: Pipeline & Gas Journal

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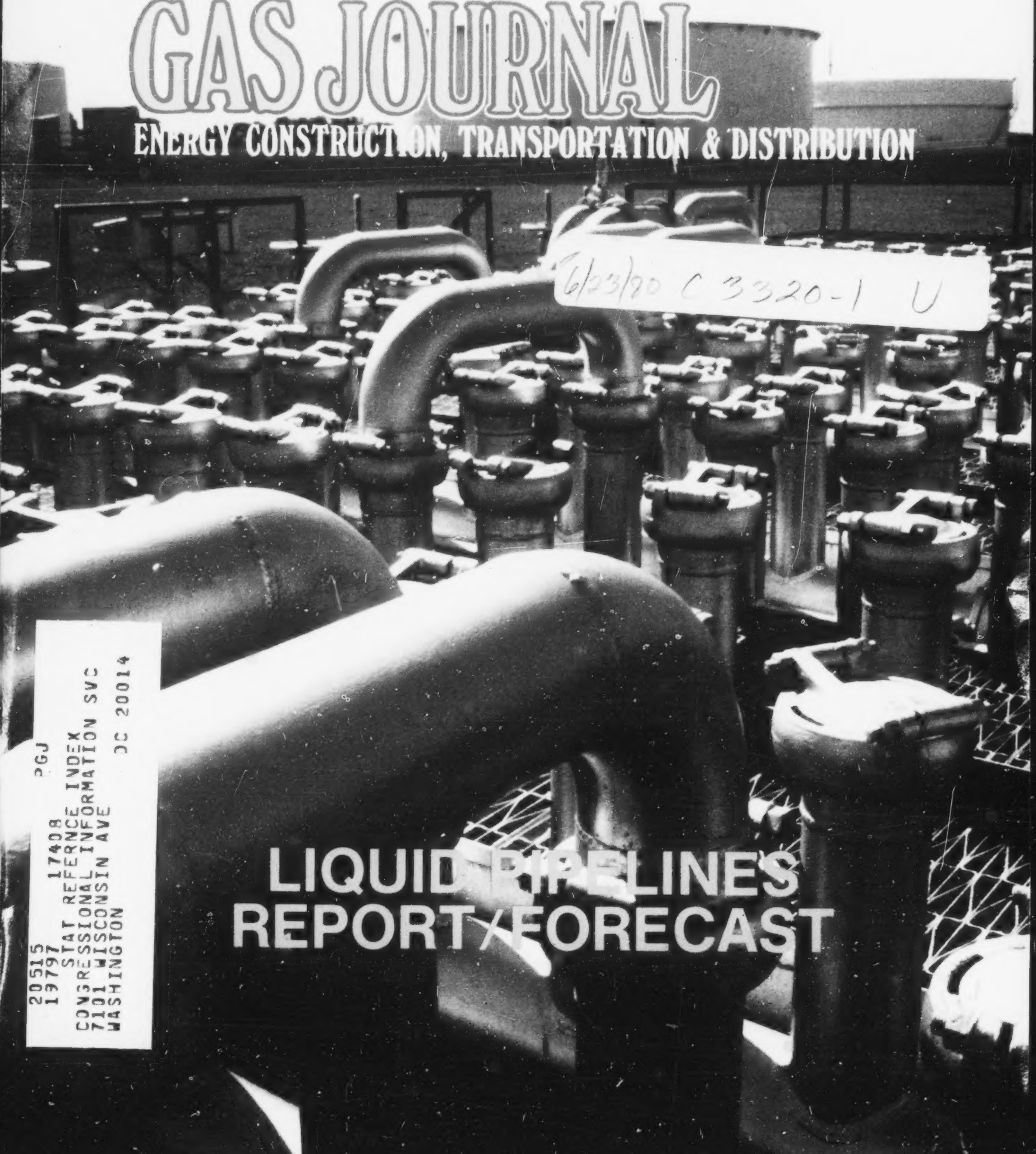

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THE COVER

Pipeline manifolds are a familiar sight at any crude oil pipeline terminal. This one belongs to Williams Pipeline Company, one of America's largest operators.

—Courtesy Williams Pipe Line Co.

11,000-Plus Miles Planned For North American Liquids 17

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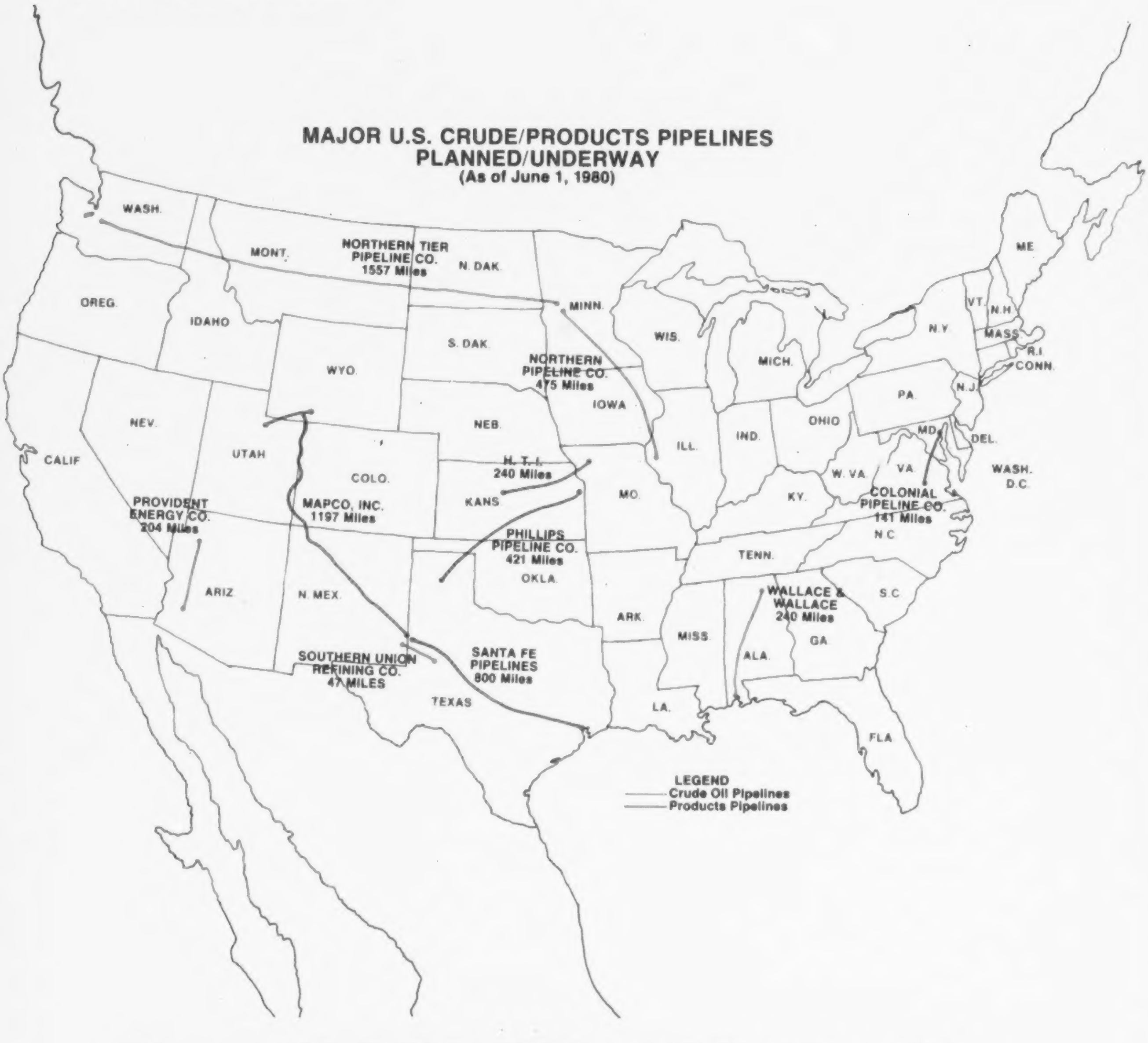
Liquids Pipeline Forecast


MAJOR U.S. CRUDE/PRODUCTS PIPELINES
PLANNED/UNDERWAY
(As of June 1, 1980)
WASH.
MONT.
NORTHERN TIER PIPELINE CO. 1557 Miles
N. DAK.
ME
OREG.
IDAHO
MINN.
VT.
N.H.
N.Y.
MASS.
R.I.
CONN.
S. DAK.
WIS.
WYO.
NORTHERN PIPELINE CO. 475 Miles
MICH.
PA.
N.J.
IOWA
NEB.
OHIO
MD.
DEL.
NEV.
UTAH
ILL.
IND.
CALIF.
H. T. I. 240 Miles
COLO.
W. VA.
VA.
WASH. D.C.
KY.
PROVIDENT ENERGY CO. 204 Miles
MAPCO, INC. 1197 Miles
KANS.
MO.
COLONIAL PIPELINE CO. 181 Miles
PHILLIPS PIPELINE CO. 421 Miles
N.C.
TENN.
OKLA.
ARIZ.
N. MEX.
WALLACE & WALLACE 240 Miles
S.C.
ARK.
MISS.
GA.
ALA.
SOUTHERN UNION REFINING CO. 47 MILES
SANTA FE PIPELINES 800 Miles
TEXAS
LA.
FLA.
LEGEND
Crude Oil Pipelines
Products Pipelines

Over 11,000 Miles Oil Pipeline Planned For U.S., Canada

by **Dean Hale**, *Editor*

Spurred by four major products pipeline projects with 1980 construction, plus another products line project to be built in 1981, the liquids pipeline business appears on its way to another premier year.

By mid-May there were a total 11,086 miles of underway, planned, and proposed crude oil pipelines and refined products/LPG/natural gas liquids pipelines on the books for the U.S and Canada. A number of the major projects and most of the smaller ones are underway.

Of the total, there are 8560 miles of underway, planned, or proposed lines in the U.S., of which 3533 miles involve crude lines and 5459 are products lines. In Canada, the Construction projects include 1926 miles of crude oil pipelines and 600 miles of products lines.

Products Lines

MAPCO Inc., in mid-April, announced that it will build a new Rocky Mountain LPG pipeline and gathering system to connect newly-discovered fields of the southwest Wyoming and northeast Utah Overthrust Belt to its existing system at Kutz, N. Mex. That extension includes 328 miles of 4-, 6-, 8-, and 10-in. gathering lines plus a 454-mile 10- and

Underway, Planned & Proposed Oil Pipeline Projects

U.S.—Crude Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS	CONTRACTOR OR ENGINEERING CO.
Amoco Pipeline Co.	50	N.A.	Tree Top, N. Dak.	Dunn Center, N. Dak.	Planned	
ARCO Pipeline Co.	31.5	36	Texas City, Tex.	Pasadena, Tex.	Comp. 7/15	Reading & Bates
Ashland Pipeline Co.	100	6-16	Prudhoe Bay		Start 9/80	Williams Bros. Eng. Co.
Ashland Pipeline Co. (w/DOE)	14	20	Catlettsburg, Ky.	Ironton, Ill.	Proposed	
Department of Energy	42	24	Kleer Mine Storage, Tex.	Texoma, Tex.	Approved	
	25	36	W. Hackberry Dome, La.	Block 42, W. Cameron Area	Await Start	
	13	20	S. Ohio Strategic Storage Reserve		Proposed	
Exxon U.S.A.	8	6, 10, 16	Corpus Christi Area		Planned	
Gulf Oil Corp.	61	8, 16	Iberia, Vermilion & Cameron areas, offshore La.		Before USCE	
	37	6, 12, 16	Grand Is. & S. Timbalier areas, offshore La.		Planned	
	27	12, 20	Terrebonne & Lafourche parishes, La.		Before USCE	
Koch Exploration Co.	16	6	St. Bernard & Orleans parishes, La.		Before USCE	
Locap Pipeline (Shell et al.)	53	48	Clovelly Dome, La.	St. James Terminal, La.	Underway	H.C. Price
New England Energy Co.	35	24	Portland, Me.	Sanford, Me.	Before EPA	
Northern Pipeline Co. (Delaware)	475	24	Wood River, Ill.	Pine Bend, Minn.	Planned	
Northern Tier Pipeline Co.	1557	40, 42	Port Angeles, Wash.	Clearbrook, Minn.	Engineering	Butler; Williams Bros.
Northville Industries	174	30	Texas City, Tex.	Houston-Freeport-Nederland	Planned	
Phillips Pipeline Co.	20	10	San Bernard, Tex.		Planned	
Provident Energy Co.	204	16	Kingman, Ariz.	Mobil, Ariz., Refinery (Proposed)	Planned	
Santa Fe Energy Co.	24	24	Trinity Co., Tex.		Engineering	
Shell Oil Co.	41	6, 8	Vermilion & Marsh Is. areas, offshore La.		Before USCE	
	28	12	Block 128, Mississippi Canyon, offshore La.		Planned	
	20	12	W. Delta & Grand Is. areas, offshore La.		Before USCE	
	9	8	Block 311, Mississippi Canyon, offshore La.		Planned	
Sioux Pipeline Co.	160	10	Superior, Wisc.	St. Paul, Minn.		
Southern Union Refining Co.	47	8	Midland, Tex.	Lovington, N.M.	Engineering	International Pipeline Engineers
Texaco Inc.	21	6, 8	Port Arthur, Tex.		Planned	
Texas Deepwater Port Authority	26 (Dual)	52	Offshore Freeport, Tex.	Shore		
Wallace & Wallace Chemical & Oil Co.	214	22 - 30	Mobile, Ala.	Tuskegee, Ala.	Planned	Ford, Bacon & Davis

U.S.—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS	CONTRACTOR OR ENGINEERING CO.
Barbour Energy Co., Inc.	390	20	Brownsville, Tex.	Houston	Under Study	Ford, Bacon & Davis
Battery Limits Project	525	16	Western N.D.	Duluth	Under Study	Wentworth Assoc.
Cal-Nev. Pipeline Co.	54	6	Edwards AFB, Calif.	George AFB, Calif.	Planned	
Colonial Pipeline Co.	141	36	Mitchell Junction, Va.	Dorsey Junction, Md.	Underway	Cap-Con; Worthy Bros.
Chase Transportation Co.	131	8, 12	Loops on El Dorado, Kan.	Denver, Colo. System	Underway	
	32	8, 12	Dorsey Junction, Md.	So. Baltimore	Planned	
Dorchester Gas Producing Co.	25	6	Sterling Co., Tex.		Underway	
Enterprise Products Co.	55	6	Jay, Fla.	Alabama	Underway	
	23.5	16	Houston Ship Channel	Mont Belvieu, Tex.	Comp. 5/15	W. L. Golightly
Exxon Pipeline Co.	66	8				
	28	4-8	Baytown, Tex.		Await Start	H&K Construction Co.
Getty Pipeline Co.	25	16	Delaware City, Del.	Marcus Hook, Pa.	Underway	Worthy Bros.
Hydrocarbon Transportation, Inc.	240	10	Bushton, Kans.	Plattsburg, Mo.	Comp. 6/15	Williams Bros.; Great Plains
LOOP Inc.	21	4	Fourchon Station, La.	Offshore Platform	Comp. 5/80	Santa Fe
Mapco Inc.	1197	4-6-8-10	N.M., Wyo., Colo. & Utah		Planned	
Phillips Pipeline Co.	421	16	Borger, Tex.	Paola, Kans.	Start 8/1	
Transgulf Pipeline Co.	800	24	Baton Rouge, La.	Ft. Lauderdale, Fla.	Planned gas-products conversion	
Southern Pacific Pipeline Inc.	36	24	Norwalk, Calif.	Colton, Calif.	Planned	
Union Carbide Corp.	13	6	Napoleonville, La., area		Planned	
Williams Pipeline Co.	691	24	Cushing, Okla.	Mason City, Iowa	Under Study	
	112	24	Des Moines, Iowa	Mason City, Iowa	Under Study	

CANADA—Crude Oil Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS
Dome Petroleum	284	6-12	Peace River, Alta.	Niton Junction, Alta.	Proposed
Esso Resources Canada Ltd. (Interprovincial Pipeline Ltd.)	560	12	Norman Wells, N.T.	Zama, Alta.	Planned
Federated Pipelines Ltd.	284	4-12	Hythe, Alta.	Swan Hills, Alta.	Proposed
Husky Oil Co.	600	2-12	Alta-Sask. gathering		Planned
Interprovincial Pipeline Ltd.	28	34	Camrose Area, Alta.		Before NEB
Murphy Oil Co., Ltd.	28	10	Onity, Sask., area		Planned
Peace Pipeline Ltd.	142	12	Cutbank Lake, Alta.	Fox Creek, Alta.	Proposed

CANADA—Products Pipelines

COMPANY	MILES	SIZES (IN.)	FROM	TO	STATUS
Amoco Canada Petroleum Co., Ltd.	500	12	Sarnia, Ont.	Quebec City, Que.	Planned
Pan Canadian Petroleum Co., Ltd.	100	10	LPG line		Planned

12-in. line between Rock Springs, Wyo. and Kutz. Additionally, MAPCO will build a 415-mile, 10- and 12-in. loop of its line between Kutz and Hobbs, N. Mex.

Liquids received in the new line will ultimately move to MAPCO's Conway, Kan. plant for fractionation and further movement to markets in the upper Middle West. Connections will be made in West Texas to other pipelines for movement to the Gulf Coast.

Cost of the MAPCO project is estimated at $110 million. The total project — pipeline and related stations (35,000 hp to be added at new and existing stations) — is expected to take three years to complete. Mainline should be complete by end of 1980 with a capacity of 20,000 bbl per day. In 1981 capacity will be expanded to 65,000 bbl per day.

Phillips Pipe Line Co. will install a new 421-mile, 16-in. products pipeline between Borger, Tex. and Paola, Kan. this year that will replace an existing 8-in. line and enable it to close eight of 13 pump stations on the Borger-Paola segment of the Phillips pipeline system.

The 8-in. line to be replaced was laid in the early 1930's and was the first long-distance pipeline to transport several kinds of liquid petroleum products. A parallel 12-in. line installed later will remain in service. Present capacity of the 8- and 12-in. lines is 140,000 bbl per day. When the new line is completed, the 12- and 16-in. system will move the same volume but will have 21,000 less horsepower.

Santa Fe Pipeline Co. has also announced plans for approximately 800 miles of new pipeline — to be 8-, 10-, or 12-in. in size — from a Texas location a few miles east of Hobbs, N. Mex. to either the Mont Belvieu or Bay City, Tex. area.

The line will connect with MAPCO's new line from the Rocky Mountain Overthrust Belt area. It will also transport additional volume from new and expanded natural gas liquids production facilities in West Texas and the Austin Chalk areas. Cost of the pipeline, which will essentially parallel SFPL's Chaparral Pipeline System, is estimated at $70 to $75 million.

Colonial Pipeline Co. has let contracts and work is underway on the 1980 portion of the company's parallel line expansion. Approximately 141 miles of 36-in. will be laid this year between Richmond, Va. and the Baltimore, Md. area.

Work is underway on 240 miles of 10-in. line between Bushton, Kan. and Plattsburg, Mo. for Hydrocarbon Transportation, Inc. The line will transport natural gas liquids.

Chase Transportation Co. is completing 131 miles of 8- and 12-in. loops on its El Dorado, Kan. to Denver, Colo. products pipeline system.

Williams Pipe Line Co. is studying plans for approximately 700 miles of 24-in. line that would link Cushing, Okla. to Mason City, Iowa and Des Moines, Iowa.

Barbour Energy, Inc. has proposed a 390-mile, 20-in. products line between a proposed new refinery at Brownsville, to the Houston-Baytown area.

Exxon is reported to have plans to build 94 miles of 4 through 8-in. products lines in 1980, including 66 miles of 8-in. ethylene line from Baytown to Groves, Tex.

Cal-Nev Pipeline plans to install 54 miles of 6-in. this year between Edwards Air Force Base and George Air Force Base in Kern County, Calif.

Crude Oil Lines

Northern Tier Pipeline, survivor so far in the battle to move Alaskan North Slope crude oil from the West Coast to midwestern U.S. markets, is currently busy arranging financing and acquiring the remainder of its permits so it can build the 1557-mile, 40- and 42-in. pipeline from Port Angeles, Wash. to Clearbrook, Minn. Engineering design is underway (Butler Associates, Williams Brothers Engineering Co.) along with numerous other associated activities. If everything falls into place for Northern Tier by the end of 1980, work may get underway in 1981.

Locap Pipeline, the 57-mile, 48-in. line connecting Clovelly Dome of the LOOP Pipeline to St. James Terminal, is under construction and expected to be completed in mid-1980.

ARCO Pipeline has underway 32 miles of 36-in. between Texas City and Pasadena, Tex.

On the west coast, at Long Beach Harbor, **Shell Oil Co.** is installing a 16-mile, 16-in. line.

Northern Pipe Line Co. (Delaware) continues to be stymied in its efforts to build a 475-mile, 24-in. pipeline between Wood River, Ill. and Pine Bend, Minn., near the Twin Cities. Biggest obstacle is the State of Iowa, which has expressed a distaste for pipelines of any type. Further court action is expected to help advance this job.

Provident Energy Co. has proposed a 204-mile, 16-in. line in Arizona, between Kingman and a new refinery at Mobil, Ariz.

Sioux Pipeline Co. is studying a proposal to build a 160-mile, 10-in. crude line linking Superior, Wis. and the St. Paul, Minn. area.

Department of Energy has four projects on its boards, involving 94 miles of pipeline, ranging from 20-in. to 36-in., that would serve major storage areas of the Strategic Petroleum Reserve program.

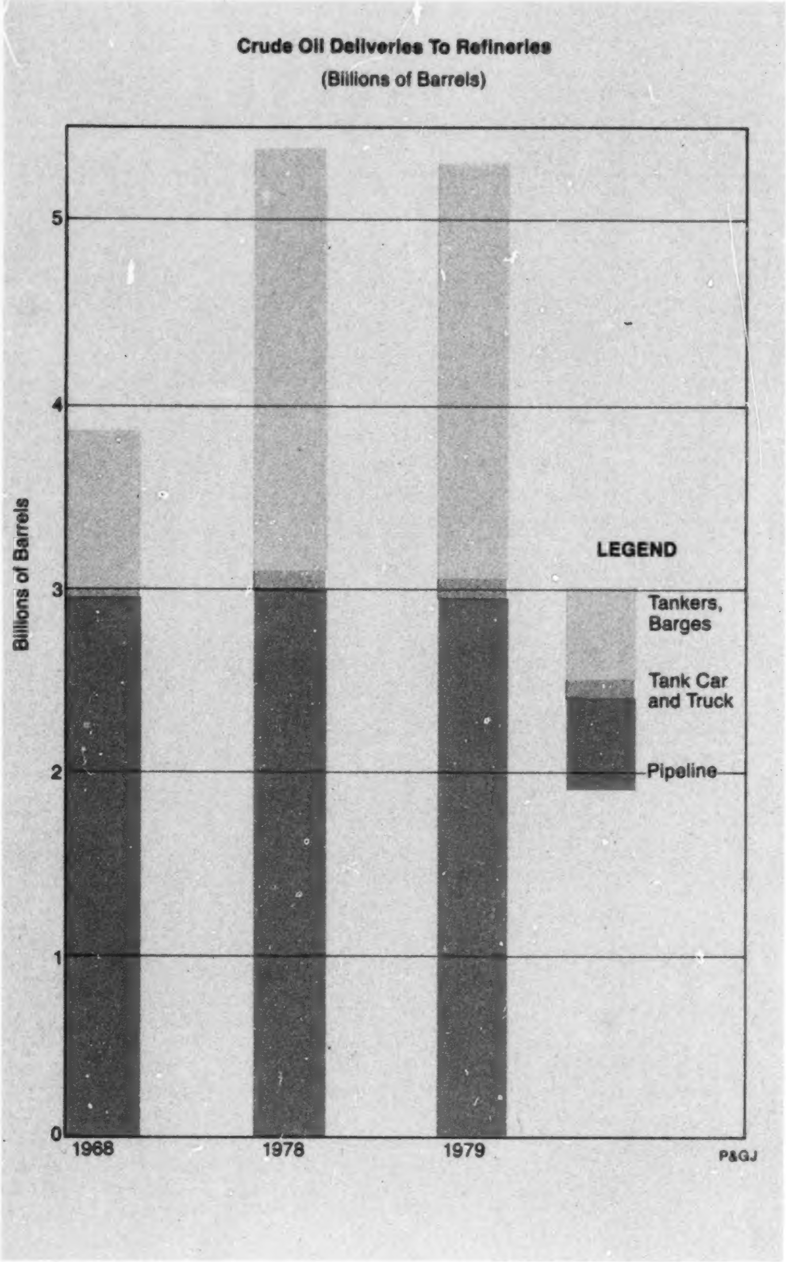
Gulf Oil Co. has 125 miles of 6- through 20-in. planned in three offshore projects in Louisiana.

Southern Union Refining Co. plans a 47-mile, 8-in. between Midland, Tex. and Lovington, N. Mex.

Wallace & Wallace Chemical & Oil Corp. has proposed a 214-mile, 22- through 30-in. crude line between Tuskegee and Mobile, Ala. **P&GJ**

Crude Pipeline Volumes Down, Products Line Deliveries Up

by John P. O'Donnell



Increasing dependence on foreign crude oil and decreasing demand for gasoline are among a number of factors that are changing long-standing patterns in liquid pipeline traffic.

More significant of these changes include:

1. Pipelines are moving a much smaller share of the crude oil deliveries to refineries,
2. Gasoline represents a declining share, and natural gas liquids a growing share, of the products pipeline mix, and
3. The products pipeline movement from the Gulf Coast to the Midwest, led by natural gas liquids, has dropped sharply.

In 1969, pipelines delivered more than 75% of the crude oil received at refineries and tankers and barges, about 22%. In 1979, the share of the deliveries made by pipeline dropped to 56%, while that of tankers and barges rose to over 42%.

The change in the proportions between the two modes of transportation resulted entirely from a huge increase in tanker deliveries. They were up more than 2½ times while deliveries by pipeline were practically unchanged.

While the total volume of crude oil delivered to refineries by pipeline is virtually unchanged from a decade ago, there are some pronounced changes in the origin of the crudes pipelines handled (Table 2). They handle less domestic crude, both intrastate and interstate, but more than three times as much foreign crude. The volume of intrastate crude was down more than that of interstate.

Pipeline deliveries of refined products continued to increase last year despite a drop in gasoline, which has represented 55% of the products pipeline mix. This continued a trend that has persisted through the past decade as gains in other products offset the drop in gasoline.

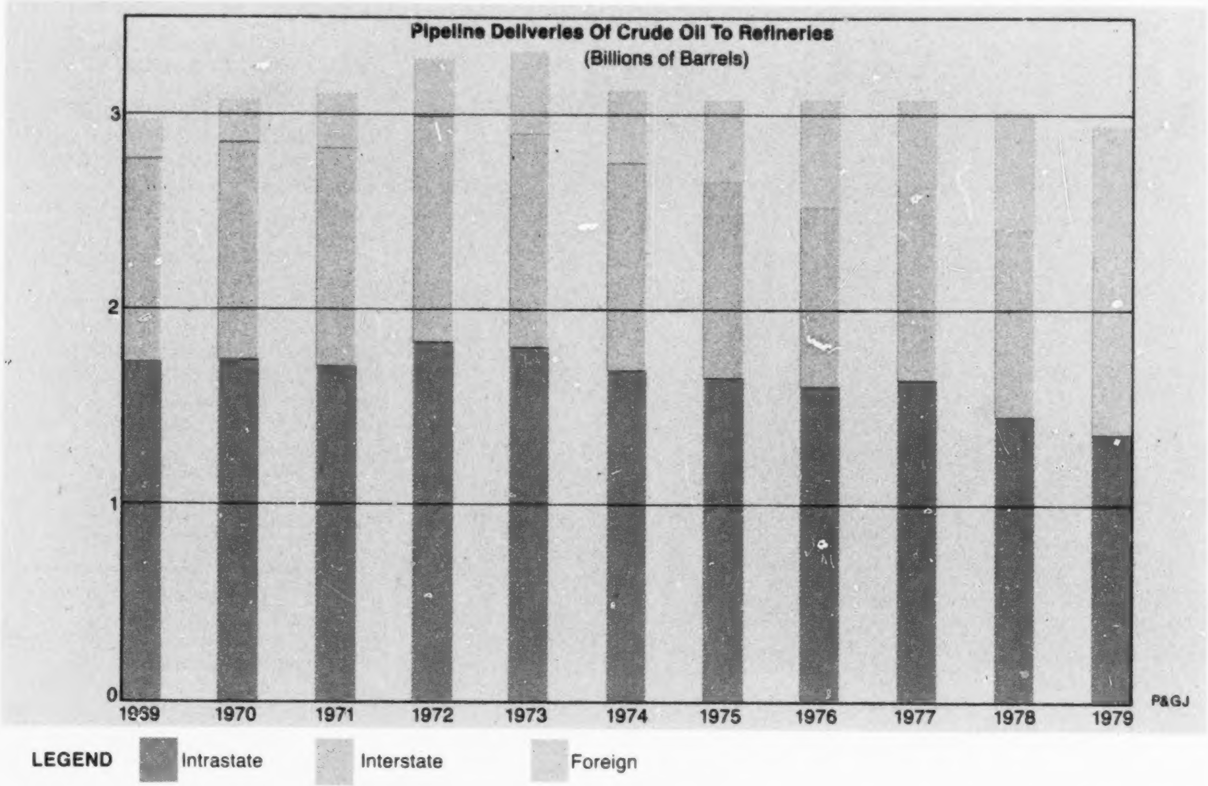
Today's more fuel-efficient cars and

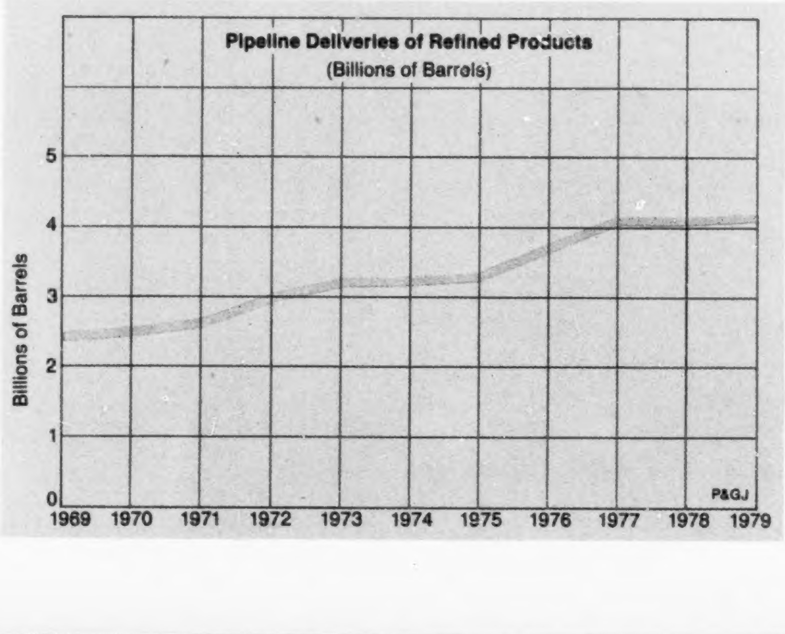
TABLE 1
Crude Oil Deliveries to Refineries

Transportation Means	1969 (1,000 bbl)	1969 Percent	1978 (1,000 bbl)	1978 Percent	1979 (1,000 bbl)	1979 Percent
Pipeline	2,969,278	76.6	3,012,031	56.1	2,949,829	55.6
Tank cars, trucks	47,833	1.2	94,249	1.7	109,053	2.0
Tankers, barges	861,412	22.2	2,266,710	42.2	2,249,478	42.4
Totals	**3,878,523**	**100.0**	**5,392,990**	**100.0**	**5,308,360**	**100.0**

TABLE 2
Pipeline Deliveries of Crude Oil to Refineries
(Thousands of Barrels)

Year	Intrastate	Interstate	Foreign	Total
1969	1,715,126	1,054,931	199,221	2,969,278
1970	1,730,513	1,109,354	236,798	3,076,665
1971	1,702,214	1,132,284	260,361	3,094,859
1972	1,832,042	1,131,777	317,774	3,281,593
1973	1,796,892	1,108,101	408,740	3,313,733
1974	1,692,458	1,061,441	370,654	3,124,553
1975	1,641,014	1,020,686	413,183	3,074,883
1976	1,599,059	937,393	560,731	3,097,183
1977	1,622,620	1,020,118	443,026	3,085,764
1978	1,461,922	962,008	563,129	2,987,059
1979	1,365,543	912,802	671,484	2,949,829





more conservative driving habits dropped gasoline's share of the mix from just under 55% in 1978 to slightly less than 53% in 1979. All other products were up with the largest gain coming in natural gas liquids. They accounted for 16.4% of the mix in 1979 against 15% in '78.

Natural gas liquids have increased their share of the mix steadily over the past ten years. They were 12% of the total in 1969 and 16.4% in 1979.

The big products pipeline movement continues to be that from the Gulf Coast to the East Coast. In 1979 this movement topped 2,000,000 bbl per day for the first time. This dependence of the East Coast on Gulf Coast refining capacity is, of course, a reflection of the continued refusal of authorities along the Atlantic seaboard to permit new refinery construction.

Such shipments did decline in 1974,

TABLE 3
Pipeline Deliveries of Refined Products
(Thousands of Barrels)

Year	Gasoline	Jet Fuel	Kerosine	Distillate Fuel Oil	Natural Gas Liquids	Other	Total
1969	1,358,579	179,920	68,185	540,482	292,763	0	2,439,909
1970	1,423,395	187,928	61,359	559,785	327,926	0	2,559,763
1971	1,466,816	204,736	51,202	583,230	338,796	0	2,644,780
1972	1,638,756	226,317	46,132	659,409	397,326	0	2,987,940
1973	1,760,580	247,035	45,086	720,997	431,228	0	3,204,926
1974	1,774,498	244,719	35,822	701,650	468,567	0	3,225,256
1975	1,822,830	259,578	30,864	667,058	504,714	0	3,285,044
1976	2,003,207	323,233	30,399	745,335	567,070	2,976	3,672,220
1977	2,205,041	34[illegible],285	34,876	858,463	603,847	2,349	4,063,164
1978	2,255,774	355,691	29,343	851,683	618,514	1,486	4,112,491
1979	2,205,914	379,428	29,982	866,127	684,921	3,325	4,169,697

TABLE 4
Changes in Products Pipeline Mix
(Thousands of Barrels)

	1969		1978		1979	
Product	Quantity	Percent	Quantity	Percent	Quantity	Percent
Gasoline	1,358,579	55.7	2,255,774	54.9	2,205,914	52.9
Jet Fuel	179,920	7.4	355,691	8.7	379,428	9.1
Kerosine	68,185	2.8	29,343	0.7	29,982	0.7
Dist. Fuel Oil	540,482	22.1	851,683	20.7	866,127	20.8
Nat. Gas Liq.	292,763	12.0	618,514	15.0	684,921	16.4
Totals	**2,439,909**	**100.0**	**4,112,491**	**100.0**	**4,166,372**	**100.0**

TABLE 5
Products Pipeline Deliveries from Gulf to East Coast
(Thousands of Barrels)

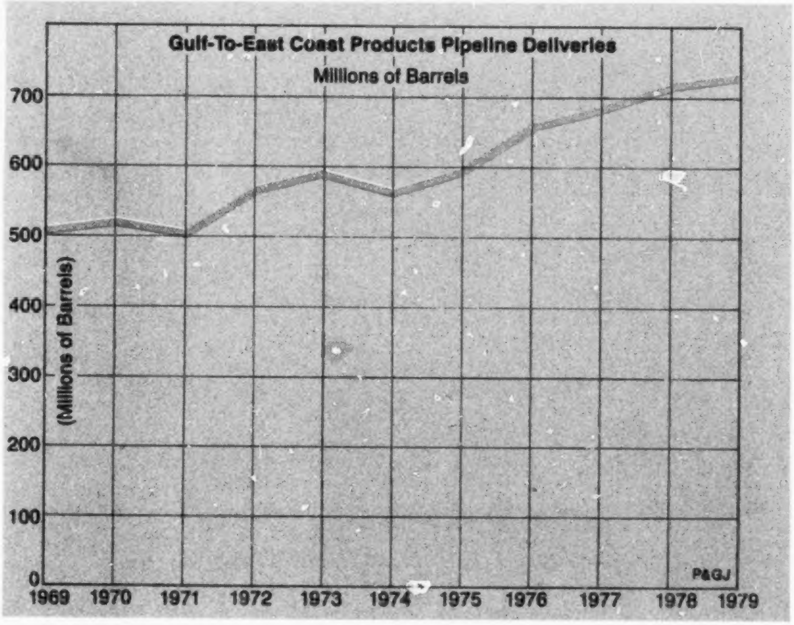
Year	Gasoline	Jet Fuel	Kerosine	Distillate Fuel Oil	Natural Gas Liquids	Totals
1969	285,058	40,750	16,580	160,203	12,060	514,653
1970	299,022	42,085	15,478	156,875	13,089	526,549
1971	286,379	41,194	14,646	155,534	14,705	512,458
1972	307,159	49,332	12,959	179,493	16,603	565,546
1973	329,835	55,504	11,134	180,331	18,112	594,916
1974	321,271	51,375	8,147	173,417	15,846	570,056
1975	353,513	50,448	8,719	167,474	17,380	597,534
1976	394,587	52,622	10,963	183,913	19,798	661,883
1977	416,523	54,951	10,299	190,892	18,932	691,597
1978	436,105	61,238	9,552	194,210	19,894	720,999
1979	437,684	65,411	10,066	204,366	22,293	733,820

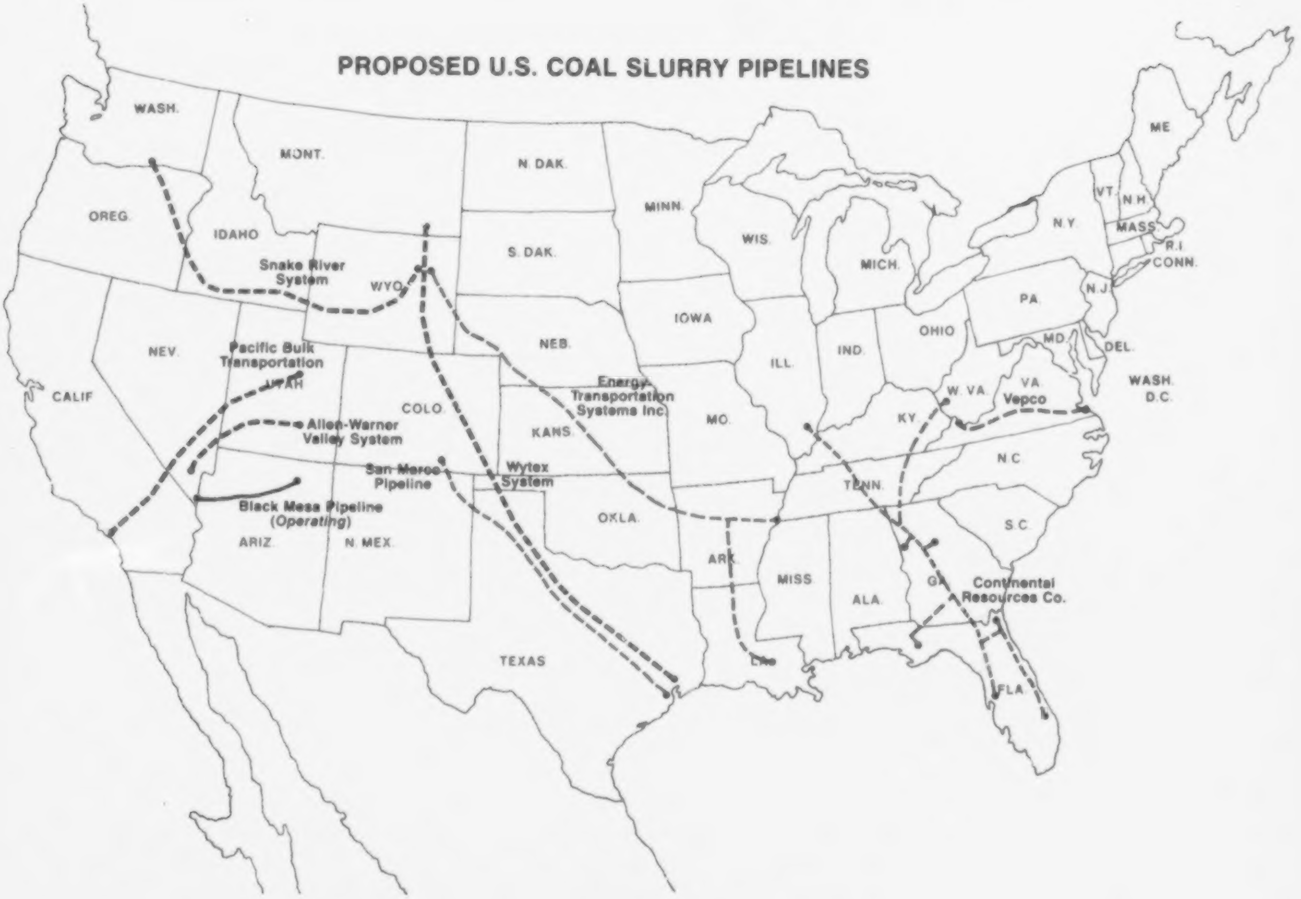
following the Arab oil embargo, but resumed their climb the following year and have since continued to increase. They were 43% higher in 1979 than they were 10 years earlier.

The dominance of the Gulf Coast-East Coast movement is shown in a comparison between it and the Gulf Coast-Midwest movement, the second largest. It's almost four-to-one.

Products shipments from the Gulf Coast (District 3) to the Midwest (District 2) dropped sharply last year. They fell from 227 million bbl in 1978 to 197 million bbl in 1979, a drop of 13%. Almost all the decline, surprisingly, was in natural gas liquids, down 38 million bbl or 28%.

There were no particularly significant changes in other interdistrict movements except between Districts 1 and 2. Shipments from District 1 to 2 were down 5 million bbl and from District 2 to 1, up 5 million, equivalent to a net gain of 10 million bbl for the East Coast. **P&GJ**




PROPOSED U.S. COAL SLURRY PIPELINES
WASH.
MONT.
N. DAK.
MINN.
ME.
OREG.
IDAHO
S. DAK.
WIS.
MICH.
N.Y.
VT.
N.H.
MASS.
R.I.
CONN.
Snake River System
WYO.
PA.
N.J.
IOWA
NEB.
OHIO
NEV.
Pacific Bulk Transportation
UTAH
ILL.
IND.
MD.
DEL.
CALIF.
Energy Transportation Systems Inc.
W. VA.
VA.
Vepco
WASH. D.C.
COLO.
Allen-Warner Valley System
KANS.
MO.
KY.
San Marco Pipeline
Wytex System
N.C.
TENN.
Black Mesa Pipeline (Operating)
OKLA.
S.C.
ARIZ.
N. MEX.
ARK.
MISS.
ALA.
GA.
Continental Resources Co.
TEXAS
LA.
FLA.

Slurry Projects Moving Ahead, Over 8000 Miles Planned

by **Dean Hale**, Editor

Coal slurry pipeline proponents continue to be optimistic about the future of moving coal hydraulically through long distance pipelines in competition with other transportation forms despite two major obstacles — lack of federal legislation giving them right of *eminent domain* and access to water needed to make the slurry.

Both of the obstacles are being overcome through continuing education of Congress and state legislative bodies, and through research and technological developments. Current economics may also be on the side of the long distance pipelines, whose studies indicate that they can operate more cheaply than other transportation methods whose costs continue to skyrocket and whose coal transportation rates have steadily increased.

Presently, there are nine announced coal slurry projects in the U.S., involving some 8271 miles of pipeline planned, proposed, or under study.

Energy Transportation Systems, Inc.'s proposal involving 1378 miles of either 38- or 42-in. to transport up to 37.5 million tons of coal per year from Wyoming's Powder River Basin to electric generating plants in Oklahoma, Arkansas, and Louisiana is the most advanced of these projects. ETSI is also studying the possibility of building a trans-shipping point on the Mississippi River.

ETSI has won all 65 court cases it filed to validate its right to cross under railroad tracks at key locations along its pipeline route. Four of the decisions were appealed to the U.S. Circuit Courts, and all four appeals were denied. The affected railroad has decided not to protest them to the U.S. Supreme Court. Two remaining appeals are before the Oklahoma Supreme Court. ETSI currently has state eminent domain rights, favorable court rulings, or railroad concurrence in all of the six principal states through which its pipeline will pass. ETSI says it expects to acquire nonrailroad right-of-way for the length of the pipeline under normal procedures.

State air pollution control permits for three slurry preparation plants in the Powder River Basin have been issued to ETSI by the Wyoming Department of Environmental Quality. At the plants, where coal will be crushed and mixed with water to form the slurry, wet scrubbers will be used to suppress coal dust during crushing operations.

ETSI was granted state approval in 1974 to use up to 20,000 acre feet of water per year from the Madison Formation, a deep underground aquifer. The firm, anticipating greatly accelerated demand for domestic coal because of conversion from petroleum and natural gas, has enlarged the scope of studies of the project to consider building a 42-in. line with the larger 37.5 million tons per year coal-carrying capacity.

The environmental impact statement for the ETSI project is well along following public "scoping" meetings held in late 1979 by the Bureau of Land Management. Full public hearings are planned for late 1980 and BLM expects the final EIS to be completed by mid-1981.

Work on a coal evaluation program to confirm the behavior of specific coals to be shipped in the line — is underway and is to be completed in 1981. Negotiations on firm contracts are also continuing with several shippers.

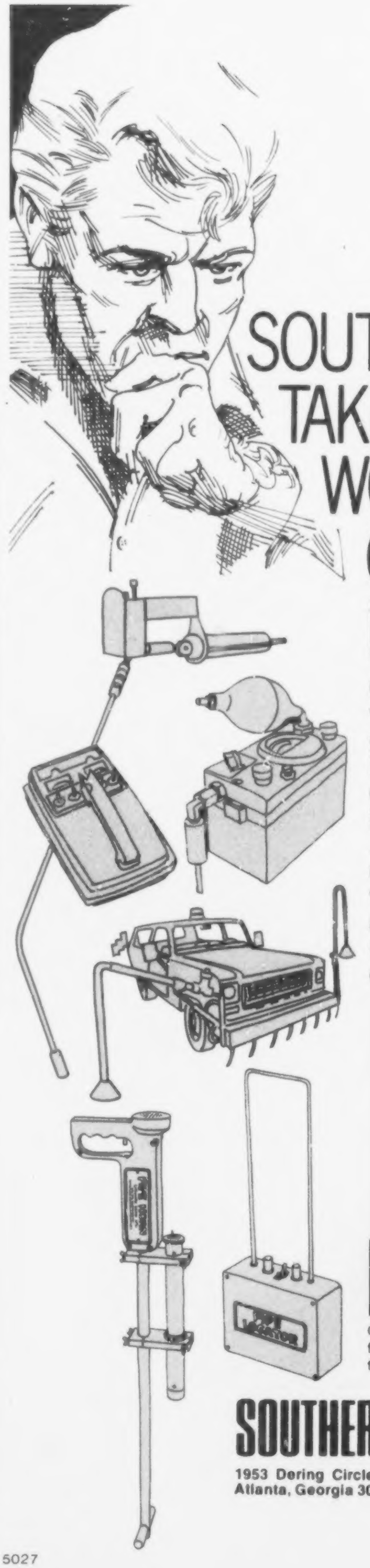
ETSI's goal is to begin construction in 1982 and have the pipeline operating in 1984.

San Marco Pipeline Co., owned jointly by Houston Natural Gas Corp. and Rio Grande Industries (parent company of the Denver & Rio Grande Western Railroad), is planning a 900-mile, 20- and 24-in. slurry pipeline system to deliver 10 million tons of coal annually to the Texas Gulf Coast area.

San Marco's concept would use the Rio Grande rail system as a coal gathering network to collect the coal at a slurry preparation facility at Walsenburg, near the southeast corner of Colorado.

Acquisition of a usable water supply is the main thrust of the project and San Marcos has acquired land southeast of Alamosa, Colo. as a center for its water exploration program. Extensive seismic and aerial magnatronic work has been conducted, and some 45 wells have been drilled on the company property and surrounding area. The test program has proven successful to date and San Marcos believes it has found an exceptionally good reservoir and that the water source is not tributary to any stream or compact. The firm has filed for 15,000 acre feet of water per year through the Colorado water court system.

Continental Resources Co. (formerly Florida Gas Co.) has proposed a 1500-mile system that would transport coal from areas in southern Illinois, western West Virginia, Kentucky, and Tennessee to electric generating plants in Georgia and Florida. Pipe



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sizes would range from 14- to 36-in. and annual capacity would be approximately 30 million tons. Water supplies are not believed to be difficult because of the stream flow in the Ohio River Basin. Right-of-way acquisition might be more difficult because of the small size of parcels of land and the difficult terrain encountered in the eastern and southeastern regions.

Nevada Power Co.'s Allen-Warner Valley Energy Systems project, would transport coal in slurry form in the states of Utah, Arizona, and Nevada to supply two new power plants. The Department of Interior is currently reviewing the environmental impact statement of the project. The pipeline —183 miles of 22-in.—would transport 11.6 million tons of coal annually over isolated, high, dry plateau country. A major problem faced by the project is that of obtaining a permit to mine coal in southwest Utah near the Bryce and Zion National Parks.

Texas Eastern Corp., in conjunction with Brown & Root, has proposed the Wytex System, a 1260-mile, 36- and 40-in. coal slurry pipeline from the Powder River Basin of Wyoming to the Houston area to move about 22 million tons of coal per year.

The project currently is "on hold" because Wyoming Gov. Herschler stopped further consideration by denying the project water under legislation passed by the Wyoming State Legislature.

Snake River Pipeline System, a joint venture of Northwest Energy Co. and Gulf Interstate Engineering Co., Houston, proposes to move 10 million tons of coal annually through a 1100-mile pipeline to supply—initially — new steam-electric generating plants at Boardman, Ore. and Boise, Ida. Other utility generating plants would be required as customers to hasten development of the project.

Pacific Bulk Transportation Systems, proposed by Boeing Engineering and Construction Co., would function as a transportation system for coal in slurry form that is destined for export shipment to Japan, Korea, and Taiwan. Boeing's proposal involves a 650-mile pipeline from central Utah to a port facility near Oxnard, Calif. Water sources for the project are secure, says Boeing, and eminent domain would not be necessary to transport the coal to the West Coast. The project, however, has not advanced beyond the feasibility stage.

Tesoro Petroleum Corp. has announced a major coal slurry proposal, involving 1000 miles of pipeline that would transport coal from Kentucky mines to electric generating plants in the southeastern states. Project feasibility is being studied for Tesoro by Fluor Corp. and Dames & Moore.

U.S. COAL SLURRY PIPELINE PROJECTS

Company	Miles	Size (In.)	From	To	Annual Tonnage
Energy Transportation Systems Inc.	1378	38 or 42	Powder River Basin, Wyo.	Oklahoma, Arkansas, Louisiana	25 MM to 37 MM
San Marco Pipeline Co. (Houston Natural Gas, Rio Grande Industries)	900	20/24	Southeast Colorado-New Mexico Border	Texas Gulf	15 MM
Allen-Warner Valley Energy Systems (Nevada Power Co.)	183	22	Alton, Utah	Las Vegas, Nev.	11.6 MM
Continental Resources Co.	1500	14/36	So. Illinois-E. Kentucky-Tennessee	Georgia, Florida	30 MM
Virginia Electric Power Co.	300	12/36	Proud, W. Va.	Portsmouth, Va.	10 MM
Wytex System (Texas Eastern, Brown & Root)	1260	36/40	Powder River Basin, Wyo.	Houston, Tex. area	22 MM
Snake River System (N.W. Energy, Gulf Interstate)	1100	N.A.	N.E. Wyoming	Idaho, Oregon	10 MM
Pacific Bulk Transportation Systems (Boeing Engineering & Construction Co.)	650	N.A.	Central Utah	Oxnard, Calif.	10 MM
Tesoro Petroleum Corp.	1000	N.A.	Kentucky	Southeastern States	N.A.

Virginia Electric Power Co. of Richmond, Va. has its proposal for a 300-mile, 12- to 36-in. coal slurry pipeline in the advanced feasibility study state. The line, which would originate at Proud, W. Va., would transport coal for use in coal-fired electric generating stations in Virginia, extending to Portsmouth, Va. A major obstacle is that Virginia is the only state with a law specifically blocking coal pipelines from using the power of eminent domain to obtain land for the pipeline route. Repeal of the state law would be necessary to build the pipeline.

Legislation Progress

The Coal Pipeline Act of 1980 (H.R. 4370) is currently being considered in the U.S. House of Representatives. This bill was introduced by a number of members from Texas—Eckhardt of Houston, Loeffler and Kazen of San Antonio, Wright of Ft. Worth. Udall of Arizona is also a sponsor. A similar bill was also reported by the House Interior Committee. Hearings on H.R. 4370 have been held by a subcommittee of the House Public Works Committee and a markup to full committee consideration was planned for late May. A final bill for full House consideration would have to involve a reconciliation of differences between the Interior version and the Public Works version.

Among those differences is that the Interior Committee bill has the Department of Interior as a certifying agency for private lands where the right of eminent domain would be used and the Public Works Committee Bill has the Interstate Commerce Commission as certifying agency for railroads, et al.

In early May, Sen. Dale Bumpers, D-Ark., introduced a bill (S.2665) that would amend the Mineral Leasing Act and give right of eminent domain to coal slurry pipelines. Hearings on this bill were expected to begin in late May by a subcommittee of the Senate Energy Committee, chaired by Sen. Bumpers.

Economic Study Reported

Just one major coal slurry pipeline could save electric utility customers from $4 to $8 billion during the decade of the '90s, a national consulting firm has estimated. Residential customers would get about 45% of the savings directly, according to the study by National Economic Research Associates, Inc. (NERA). The NERA study utilized data from a feasibility study by Continental Resources Co. of its proposed coal slurry pipeline from Southern Appalachia and southern Illinois coal basins to Georgia and Florida.

The study projected cost differentials in coal transportation ranging from $2.04 per ton 1990 to $20.74 per ton in 2000, with the major expense increase being in fuel and wages by competing transport forms. Fuel savings alone would involve 3,337,000 bbl of diesel fuel in 1990, and up to 4,845,000 bbl in the year 2000.

Technological Advances

Serious consideration is being given to the carrying mediums for coal as a slurry in pipelines. Rather than use the 50% coal-50% water ratio used by the nation's major operating coal slurry pipeline — the Black Mesa Pipeline in Arizona — researchers are aiming for a 70% coal-30% water mixture.

Other proposals involve the use of liquid carbon dioxide as a carrying medium for coal from the Powder River Basin in Wyoming in an open-loop system. The CO_2 would be recovered and used for tertiary recovery in some of the older oilfields in Texas. Also being considered is a closed-loop in which the CO_2 would be recovered and returned to the origin end of the slurry pipeline. In such a system, a second, smaller pipeline would be required for the return movement.

Crude oil has also been suggested as a medium for carrying coal slurry. Such a system would require development of plants (or modification of existing oil refineries) to utilize a coal-oil mixture to also produce coal derived liquids and products.

Methanol has also been proposed as a coal carrying medium. Methanol can be manufactured from coal and fuel-grade methanol is a clean boiler fuel and/or gasoline substitute. Research to date indicates that methanol could be effectively used, but considerable development and research work still must be performed.

Finally, technology is advancing in the coarse — or heterogeneous — slurry system area. This approach is used primarily in moving coal to the surface from deep mines. Such systems would make it possible for a requisite amount of coal to be mined to feed coal gasification plants, coal liquefaction plants, and mine-mouth generating stations. The DOE is spending $7 million to develop such a system to work in a 4-ft seam to move coal to the surface at rates of five to seven tons per minute.

European Slurry Pipelines

Only two slurry lines of any significance exist in Western Europe today and prospects for further development of slurry pipelines will depend on their having great economic advantages. That's because existing transport networks — highways, railroads, and waterways — are well developed, reliable, and heavily subsidized by government.

Despite those facts, there are at least eight major slurry pipeline prospects being given consideration today, and some of those are expected to eventually come into being. They include:

Iron Ore Slurry Pipelines	**Tons/Yr**
1. Rotterdame to Ruhr District	36 MM
2. Zeebrugge or Dunkirk to Luxembourg and Saar District	N.A.
3. Trieste or Bakar to Linz, Austria (500 km)	N.A.
4. North Sea to Salzgitter (250 km)	3 MM
Coal Slurry Pipelines	
5. Ruhr District to S. Germany (548 km)	2.24 MM
6. Ruhr District to Salzgitter (200 km)	3-4 MM
7. Katowice, Poland to Linz, Austria (400 km)	5 MM
8. Saar District — Local Delivery (30 km)	2 MM

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"Windfall Profits" Tax Impact Felt

by Julie Fonner, *Assistant Editor*
Energy Management Report

The "windfall profits" tax (WPT) went into effect March 1, 1980. Oil companies felt its impact in their first quarter reports.

Standard Indiana said "the impact of the 'windfall profits' tax will grow substantially as the crude oil price decontrol program progresses."

Cities Service, Superior Oii, Texaco, Conoco, Shell all reported domestic earnings diminished by WPT.

Atlantic Richfield paid $31 million in "windfall profits" taxes in the first quarter; Standard Oil of California paid $24 million; Southland Royalty paid $3.4 million; Standard Indiana paid $34 million; Gulf Oil paid $31 million. (These millions in taxes were paid on operations for the month of March only.)

Sohio's response to WPT: "Despite this major setback in funding energy development, Sohio intends to do its best to find and develop new energy resources within the restrictions imposed by this new excise tax."

Phillips Petroleum said "Higher taxes, both in the U.S. and abroad, and lower profit margins in domestic refining/marketing operations and chemical activities are expected to adversely affect earnings during the last nine months of the year."

Gas companies reported increased oil/natural gas volumes from their production departments. United Energy Resources' Cotton Petroleum increased gas production 42%. Houston Natural Gas increased gas production 56%.

TransCanada PipeLines acquired interest in oil/gas properties in western Canada in 1979. "While no significant net earnings contribution is estimated from oil/gas properties this year, this operation has a

FIRST QUARTER GAS COMPANIES FINANCIAL REPORTS

	Three months ending March 31**							
	Revenues ($000)			Earnings* ($000)			Profit Margin**	
	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979
Alabama Tennessee N.G.	26,778	14,673	+ 82.5	1,324	805	+ 64.5	4.9	5.5
Alberta Gas Trunkline	480,800	141,400	+240.0	29,338	20,350	+ 44.2	6.1	14.4
American Nat. Resources	976,333	710,873	+ 37.3	54,160	53,576	+ 1.1	5.5	7.5
Arkla Gas Co.	286,312	186,992	+ 53.1	35,922	22,972	+ 56.4	12.5	12.3
Coastal Corp.	1,446,364	987,071	+ 46.5	26,391	20,755	+ 27.2	1.8	2.1
Columbia Gas	1,303,000	992,432	+ 31.3	83,800	80,425	+ 4.2	6.4	8.1
Commonwealth Nat. Res.	70,095	45,223	+ 55.0	3,075	2,440	+ 26.0	4.4	5.4
Consolidated N.G.	953,206	704,316	+ 35.3	70,003	62,452	+ 12.1	7.3	8.9
El Paso Companies	1,028,388	559,179	+ 83.9	34,748	31,289	+ 11.1	3.4	5.6
Enserch Corp.	694,687	579,299	+ 19.9	45,290	33,066	+ 37.0	6.5	5.7
Equitable Gas	125,326	104,659	+ 19.7	16,680	14,302	+ 16.6	13.3	13.7
Internorth Inc.	938,396	685,547	+ 36.9	111,114	71,512	+ 55.4	11.8	10.4
Kansas Nebraska N.G.	99,162	85,845	+ 15.5	8,197	7,571	+ 8.3	8.3	8.8
Mountain Fuel Supply	129,025	105,492	+ 22.3	14,950	12,215	+ 22.4	11.6	11.6
National Fuel Gas[1]	489,658	388,880	+ 25.9	30,978	29,119	+ 6.4	6.3	7.5
Northwest Energy	431,500	290,000	+ 48.8	18,100	11,200	+ 61.6	4.2	3.9
Oklahoma N.G.[2]	277,401	242,516	+ 14.4	17,498	16,914	+ 3.5	6.3	7.0
Pacific Lighting	901,195	544,655	+ 65.5	22,700	30,406	- 25.3	2.5	5.6
Panhandle Eastern	657,187	487,100	+ 34.9	60,878	52,544	+ 15.9	9.3	10.8
Peoples Energy	1,075,862	819,922	+ 31.2	66,242	68,662	- 3.5	6.2	8.4
Pioneer Corp.	210,483	157,815	+ 33.4	23,430	12,009	+ 95.1	11.1	7.6
Southern Nat. Res.	553,215	381,853	+ 44.9	37,194	27,978	+ 32.9	6.7	7.3
Southern Union Co.	255,708	196,215	+ 30.3	18,048	14,061	+ 28.4	7.1	7.2
Texas Eastern Corp.	1,090,881	684,884	+ 59.3	63,851	51,592	+ 23.8	5.9	7.5
Texas Gas Trans.	585,333	406,192	+ 44.1	25,073	15,929	+ 57.4	4.3	3.9
TransCanada PipeLines	782,892	627,315	+ 24.8	22,050	20,889	+ 5.6	2.8	3.3
Transco Companies	586,235	339,362	+ 72.7	28,357	15,144	+ 87.2	4.8	4.5
United Energy Res.	1,034,782	671,010	+ 54.2	41,702	26,402	+ 58.0	4.0	3.9
Westcoast Trans.	436,986	276,215	+ 58.2	12,728	12,651	+ 0.6	2.9	4.6
TOTAL	17,927,190	12,416,935	+ 44.4	1,023,821	839,230	+ 22.0	5.7	6.8

*Earnings available to common. **Excluding non-recurring items. [1] Six Months.
[2] Three months ending Feb.29

FIRST QUARTER OIL COMPANIES FINANCIAL REPORTS

	Three months ending March 31**							
	Revenues ($000)			Earnings* ($000)			Profit Margin#	
	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979
1. Adams Res. & Energy	62,311	30,327	+105.5	(118)	156		none	0.5
2. Adobe Oil & Gas	36,085	17,543	+105.7	4,381	1,970	+122.4	12.1	11.2
3. Alaska Interstate	82,995	55,969	+ 48.3	14,221	978	+1354.1	17.1	1.7
4. Altex Oil	238	116	+105.2	24	(224)		10.1	none
5. Amarex Inc.[1]	4,650	3,488	+ 33.3	747	691	+ 8.1	10.2	19.8
6. Amerada Hess	2,325,398	1,538,611	+ 51.1	180,178	129,694	+ 38.9	7.8	8.4
7. American Petrofina	523,374	345,647	+ 51.4	31,410	11,360	+176.5	6.0	3.3
8. American Quasar	9,075	6.944	+ 30.7	2,005	625	+220.8	22.1	9.0
9. Argo Petroleum	3,229	1,901	+ 70.0	474	5	+9380.0	14.7	0.3
10. Ashland Oil	2,000,000	1,500,000	+ 33.3	47,400	30,600	+ 54.9	2.4	2.0
11. Atlantic Richfield	5,433,767	3,516,918	+ 54.5	426,119	242,211	+ 75.9	12.1	6.9
12. Baruch Foster	1,704	560	+204.3	487	78	+524.4	28.6	13.9
13. Beard Oil	5,708	2,304	+147.7	1,202	8	+14925.0	21.1	0.4
14. Belco Petroleum	211,543	125,267	+ 68.9	18,243	14,405	+ 26.6	8.6	11.5
15. Buttes Gas & Oil	40,217	32,348	+ 24.3	3,186	612	+420.6	7.9	1.9
16. C&K Petroleum	8,663	6,521	+ 32.9	1,121	374	+199.7	12.9	5.7
17. Callon Petroleum[2]	2,885	2,210	+ 30.5	1,100	422	+160.7	38.1	19.1
18. Cities Service	2,172,000	1,445,600	+ 50.3	170,100	78,500	+116.7	7.8	5.4
19. Clark O&R	402,274	258,198	+ 55.8	14,100	6,087	+131.6	3.5	2.4
20. Commonwealth OR	306,200	236,200	+ 29.6	(9,200)	10,500		none	4.5
21. Consolidated O&G[2]	7,959	6.927	+ 14.9	219	(2,284)		2.8	none
22.#Conoco Inc.	4,330,000	2,750,800	+ 57.4	328,600	161,800	+103.1	7.6	5.9
23. Crestmong O&G	3,101	1,620	+ 91.4	1,128	440	+154.6	36.4	27.2
24. Crown Central	306,230	217,117	+ 41.0	11,478	16,210	- 29.2	3.7	7.5
25. Crystal Oil	58,321	28,493	+104.7	2,887	1,091	+164.6	5.0	3.8
26. Damson Oil	7,240	4,258	+ 70.0	465	(379)		6.4	none
27. Delhi Int'l Oil	5,596	3,244	+ 72.5	1,112	578	+ 92.4	19.9	17.8
28. Diamond Shamrock	755,331	505,005	+ 49.6	56,255	29,529	+ 90.5	7.5	5.9
29. Dorchester Gas[2]	174,778	77,771	+124.7	7,583	4,138	+ 83.3	4.3	5.3
30. Dyco Petroleum	6,118	3,573	+ 71.2	1,610	792	+103.3	26.3	22.2
31. Energy Reserves Group	36,044	18,837	+ 91.3	8,487	(3,089)		23.5	none
32. Equity Oil	3,209	2,667	+ 20.3	841	544	+ 54.6	26.2	20.4
33.#Exxon	27,654,000	18,828,000	+ 56.9	1,925,000	955,000	+101.6	7.0	5.1
34. Felmont	11,948	9,126	+ 30.9	3,749	2,452	+ 52.9	31.4	26.9
35. Forest Oil	21,464	17,774	+ 20.8	2,123	2,087	+ 1.7	9.9	11.7
36. Galaxy Oil[2]	2,541	1,264	+101.0	253	(238)		10.0	none
37. General American	61,491	41,365	+ 48.7	13,722	8,053	+ 70.4	22.3	19.5
38. Getty Oil	2,268,699	1,095,691	+107.1	225,548	107,930	+109.0	9.9	9.9
39. Gulf Energy & Develop.	19,341	6,907	+180.1	1,353	561	+141.2	7.0	8.1
40. Gulf Oil Corp.	7,756,000	5,566,000	+ 39.4	389,000	249,000	+ 56.2	5.0	4.5
41. Helmerich & Payne	53,479	36,315	+ 47.3	11,930	7,535	+ 58.3	22.3	20.8
42. Houston O&M	97,282	81,642	+ 19.2	14,590	13,057	+ 11.7	15.0	16.0
43. Howell Corp.	69,286	58,832	+ 17.8	7,004	2,723	+157.2	10.1	4.6
44. Husky Oil Ltd.	270,700	188,300	+ 43.8	16,200	9,100	+ 78.0	6.0	4.8
45. Inexco Oil	30,946	22,210	+ 39.3	5,747	3,739	+ 53.7	18.6	16.8
46. Intercontinental Energy	2,226	1,896	+ 17.4	(523)	(165)		none	none
47. Juniper Petroleum	6,853	2,830	+142.2	1,491	152	+880.9	21.8	5.4
48. Kerr McGee Corp.	780,394	601,893	+ 29.7	47,142	33,442	+ 41.0	6.0	5.6
49. Kirby Exploration	20,202	18,692	+ 8.1	2,733	1,232	+121.8	13.5	6.6
50. Lear Petroleum	23,065	20,743	+ 11.2	1,865	1,376	+ 35.5	8.1	6.6
51. Louisiana L&E	264,954	160,477	+ 65.1	51,593	33,770	+ 52.8	19.5	21.0
52. MGF Oil	14,975	12,054	+ 24.2	1,255	385	+226.0	8.4	3.2
53. Mapco Inc.	239,742	152,738	+ 57.0	20,588	13,356	+ 54.2	8.6	8.7
54. Marathon Oil	2,265,368	1,473,689	+ 53.7	139,071	80,838	+ 72.0	6.1	5.5
55. Maynard Oil[2]	6,860	4,353	+ 57.6	1,392	166	+738.6	20.3	3.8
56. McCulloch Oil	26,073	15,434	+ 68.9	2,419	963	+151.2	9.3	6.2
57. McFarland Energy	3,389	1,626	+108.4	1,065	321	+231.8	31.4	19.7
58. McMoRan Oil & Gas	11,300	4,404	+156.6	2,356	362	+550.8	20.9	8.2
59. McRae Consol. O&G[2]	31,051	19,377	+ 60.3	212	1,332	- 84.1	0.7	6.9
60. Mesa Petroleum	100,578	55,398	+ 81.6	19,586	14,357	+ 36.4	19.5	25.9
61. Mitchell Energy[1]	153,156	77,442	+ 97.8	25,873	8,767	+195.1	16.9	11.3
62.#Mobil Corp.	15,278,483	10,402,247	+ 46.9	921,804	448,562	+105.5	6.0	4.3
63. Murphy Oil	569,245	363,583	+ 56.6	28,390	15,044	+ 88.7	5.0	4.1
64. Natomas	319,076	219,857	+ 45.1	48,015	18,275	+162.7	15.1	8.3
65. Noble Affliates	67,584	46,965	+ 43.9	13,459	6,229	+116.1	19.9	13.3
66. Occidental Petr.	3,346,600	1,842,600	+ 81.6	158,300	82,600	+ 91.7	4.7	4.5
67. Ocean O&G	19,963	11,394	+ 75.2	3,494	1,978	+ 76.6	17.5	17.4
68. Oxoco	2,637	1,799	+ 46.6	251	47	+434.0	9.5	2.6
69. Pacific Resources	206,960	114,587	+ 80.6	9,030	3,312	+172.6	4.4	2.9
70. Patrick Petroleum[1]	12,533	11,040	+ 13.5	(299)	402		none	3.6
71. Pauley Petroleum[2]	40,607	22,840	+ 77.8	934	(3,264)		2.3	none
72. Peninsula Resources	3,340	1,887	+ 77.0	153	119	+ 28.6	4.6	6.3
73. Pennzoil Co.	612,905	433,421	+ 41.4	82,501	44,954	+ 83.5	13.5	10.4
74. Petro-Lewis	28,341	13,830	+104.9	5,057	1,526	+231.4	17.8	11.0
75. Phillips Petroleum	3,384,162	1,987,024	+ 70.3	338,599	177,001	+ 91.3	10.0	8.9
76. Quaker State	194,860	157,155	+ 24.0	6,879	7,912	- 13.1	3.5	5.0
77. Sabine Corp.	28,075	16,328	+ 71.9	6,349	2,155	+194.6	22.6	13.2
78. Seneca Oil	1,835	570	+221.9	323	62	+421.0	17.6	10.9
79. Shell Oil	4,798,000	3,076,000	+ 56.0	373,000	224,000	+ 66.5	7.8	7.3
80. Southland Royalty	90,635	51,360	+ 76.5	18,800	10,105	+ 86.1	20.7	19.7
81. Standard Calif.	10,447,000	6,958,000	+ 50.1	627,000	343,000	+ 82.8	6.0	4.9
82. Standard Indiana	6,452,600	4,382,300	+ 47.2	576,000	350,000	+ 64.6	8.9	8.0
83. Standard Ohio	2,514,800	1,650,500	+ 52.4	450,700	167,500	+169.1	17.9	10.2
84. Sun Co.	3,100,000	2,400,000	+ 29.4	251,300	128,300	+ 95.9	8.1	5.3
85. Sundance Oil	4,284	3,944	+ 8.6	(1,082)	(1,415)		none	none
86. Superior Oil	330,287	219,228	+ 50.7	68,366	40,327	+ 69.5	20.7	18.4
87. Supron Energy	15,056	11,139	+ 35.2	4,700	3,146	+ 49.4	31.2	28.2
88. Tenneco	3,316,000	2,447,000	+ 35.5	178,000	123,000	+ 44.7	5.4	5.0
89. Tesoro	828,749	502,757	+ 64.8	41,639	9,104	+357.4	5.0	1.8
90. Texaco Inc.	13,249,000	8,358,000	+ 58.5	600,600	303,900	+ 97.6	4.5	3.6
91. Texas American	33,137	22,527	+ 47.1	686	217	+216.1	2.1	1.0
92. Texas International	14,207	6,318	+124.9	1,874	330	+467.9	13.2	5.2
93. Texas Oil & Gas[2]	294,901	223,827	+ 31.8	34,783	23,967	+ 45.1	11.8	10.7
94. Tipperary Corp.	18,757	12,664	+ 48.1	1,381	(32)		7.4	none
95. Tomlinson Oil[2]	14,393	6,160	+133.7	708	307	+130.6	4.9	5.0
96. Tosco Corp.	534,162	356,267	+ 49.9	22,629	11,101	+103.9	4.2	3.1
97. Total Petr. N.A.	314,589	174,050	+ 80.7	8,071	4,730	+ 70.6	2.6	2.7
98. Transcontinental Oil	17,990	16,357	+ 10.0	(124)	(907)	+ 86.3	none	none
99. Triton Oil & Gas[2]	5,409	2,956	+ 83.0	2,020	(35)		37.4	none
100. Union California	2,282,333	1,662,333	+ 37.3	152,922	114,104	+ 34.0	6.7	6.9
101. United Refining	149,284	102,169	+ 46.1	2,247	1,332	+ 68.7	1.5	1.3
102. Universal Resources[1]	9,287	5,644	+ 64.6	1,372	613	+123.8	14.8	10.9
103. Wainoco Oil	9,546	5,378	+ 77.5	2,930	1,490	+ 96.6	25.0	27.7
104. Westcoast Petr.	9,720	8,400	+ 15.7	2,657	2,259	+ 17.6	27.3	26.9
105. Wichita Industries	2,197	998	+120.1	354	20	+1670.0	16.1	2.0
106. Williams Companies	479,337	422,133	+ 13.6	35,123	7,439	+347.1	7.3	1.8
107. Wiser Oil	15,112	8,599	+ 75.7	5,036	2,634	+ 91.2	33.3	30.6
108. Woods Petroleum	23,143	9,960	+132.4	3,065	2,743	+ 11.7	13.2	27.5
109. Worldwide Energy	9,932	6,889	+ 44.1	1,044	62	+1583.9	10.5	0.9
TOTAL	135,113,213	90,092,931	+ 50.0	9,356,600	4,970,989	+ 88.2	6.9	5.5

*Earnings available to common. ** Excluding non-recurring items. () Loss. #Earnings* divided by revenues. [1] Ending January 31. [2] Ending February 29. #Revenues include excise taxes.

strong impact on internal cash generation," TransCanada said.

Oil and gas exploration/production division of Texas Gas Transmission posted record first quarter earnings in 1980.

Consolidated Natural Gas said "earnings increase was due to improved results from Gulf of Mexico operations."

Alabama Tennessee Natural Gas said earnings increase was due to improved gas supply.

Peoples Energy said "revenues increased in the first quarter reflecting the pass-through of higher purchased gas costs and higher market prices for (subsidiary) Harper Oil's production. Offsetting factors included gas sales declines resulting from warmer weather and continuing softness in the coal market."

Southern Union's utility earnings were down during the first quarter due to warm weather—but refinery operations were up substantially.

Commonwealth Natural Resources cited "increased supply, greater industrial sales and higher cost of product" as dominant factors contributing to increased revenues. Natural gas sales were up 17.5%.

Profits per gallon of product sold for Mobil were 5.6¢ worldwide and 4.1¢ in the U.S. Texaco made 3.4¢/gal worldwide. Standard California reports 4.0¢ profit/gallon on worldwide product sales, 3.9¢/gal in the U.S.

Sohio's pump prices, "the lowest in the nation, resulted from government crude oil and product price regulations, as well as efficient marketing and higher refinery runs" says a Sohio release.

Equity Oil's gains were from operations in Rangely Weber Sand Unit in Colorado ... Triton said its downward trend in oil/gas production has been "arrested by the success of our U.S. exploration effort, now in its third year."

Profits of Union California increased "due to improved domestic and foreign crude oil and natural gas earnings." Mesa's production was down but record earnings and revenues were achieved because of increased interest income and higher prices for new offshore production.

Natomas attributed increased earnings to Indonesian petroleum operations and said that U.S. petroleum, geothermal, coal and petroleum marketing operations also showed gains. Noble cited strong performances in all operations—oil and gas, contract drilling and trucking.

Foreign petroleum and worldwide chemical and mineral operations accounted for 86% of the first quarter earnings gain for Standard Indiana. Domestic petroleum earnings were up only 16% over the first quarter 1979 results.

All Marathon's earnings improvement in the quarter ending March 31 were from domestic sources. Net income from foreign sources was down from a year before.

Conoco attributed earnings improvement to higher margins for refined products and crude oil and increased crude oil production in the North Sea and Indonesia.

"Continued favorable results of refining and marketing activities" are cited as reasons for earnings increases for American Petrofina. ... Quaker State stated "the decline in earnings in the first quarter of this year resulted from lower earnings in the petroleum operations because of higher prices paid for purchased crude oil."

United Refining said "higher refinery runs decreased the need to purchase refined products from other suppliers. However, earnings were constrained by higher crude costs and lower refined product sales volumes".

Pacific Resources attributed its earnings increase for the quarter to strong demand for higher margin petroleum products in the foreign and bonded fuel markets.

Earnings rise due to higher prices for crude and natural gas and increased production were cited by Shell Oil, Noble Affiliates, Phillips Petroleum, Atlantic Richfield, Union California, Mobil, Southland Royalty, Consolidated Oil & Gas.

Also Dyco Petroleum, Triton Oil & Gas, Gulf Oil, Exxon, Pennzoil, Husky Oil, Statex Petroleum, Texas Oil & Gas and Universal Resources. Texaco said it got higher prices but they were offset by lower production.

Tenneco says it is beginning to reap the results of its heavy investment in energy programs over the past five years — increasing production of both domestic oil and natural gas.

Dyco Petroleum realized the full impact of several deep new gas wells coming on production — some below 15,000 ft. "These deep wells qualify for deregulated gas prices and have significantly contributed to an increase in gas sales."

Some capital expenditure budgets are changed when the first quarter results are known. Standard California increased its budget to $3 billion for all of 1980 — two-thirds will be spent in the U.S.

Atlantic Richfield will spend $3 billion in 1980; 70% in the U.S.; Cities Service is planning $1 billion to be spent—up 45% from last year and more than double that of 3 years ago.

Union California will spend $1.6 billion; 77% in the U.S. for exploration and production ... Conoco will spend $2 billion; 60% in the U.S.... Shell will spend $3.1 billion; $2.3 for energy projects.

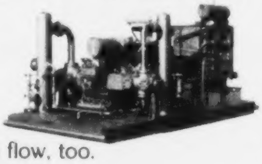
Mobil said 38% of its first quarter capital spending was in the U.S.

"The economics of using this KOA compressor are just right."

We had a group of shallow gas wells that just weren't producing enough to justify expensive compression equipment. But Ki's engineers designed a tailor-made compressor set around their KOA 100 hp unit and really turned things around.

We leased the package for a six-month trial then bought it when the lease term was up. Now we're netting substantial income from a lease that had been shut in for years.

KOA direct drive balanced-opposed compressors are available in packages of one to three stages with horsepower ranges up to 400 BHP. So if you have marginal production wells which have been shut in, chances are a Ki package could increase *your* cash flow, too.



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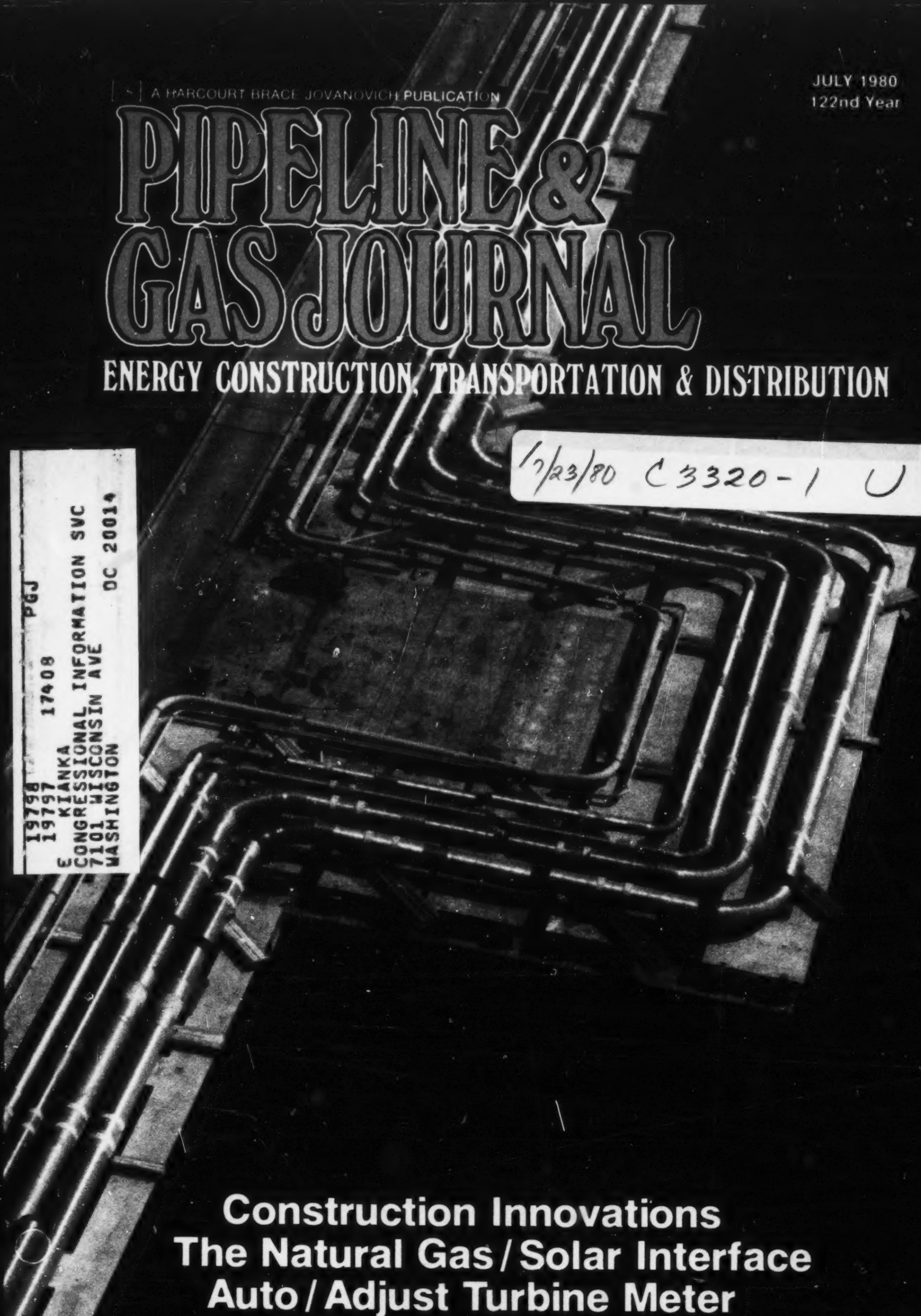

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Construction Innovations
The Natural Gas/Solar Interface
Auto/Adjust Turbine Meter

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PIPELINE & GAS JOURNAL

International Pipeline & Gas Utility Design, Construction & Operation

Published Continuously Since 1859

in this issue

JULY 1980 • VOLUME 207 • NUMBER 8

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Energy Management Report

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Construction Innovations 17

Pipeliners ... on land or on sea ... rise to meet the challenge with unique equipment applications and methods to answer specific needs; this year's crop includes a foam-filled joint for concrete pipe used offshore; a hydraulic drill that fits the end of a backhoe boom; an undersea trencher that can cut through rock; slippery pigs to coat pipes internally; a small-diameter internal lineup clamp; a special bending shoe for insulated pipe; live insertion of plastic pipe into old mains without loss of gas; a boltless flange for making subsea connections and repairs; a "superboom" for handling big (48-in. and larger) pipe that has a 100-ton capacity, and backhoe-mounted paving breakers.

The Natural Gas/Solar Interface 22

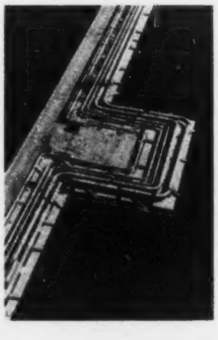
What impact will solar energy utilization have on the natural gas utility business? There are many problems foreseen, beginning with the question of whether full-time gas customers should utilize (through rates) the night-time, part-time user of gas energy ... and going on through the probability of gas utility-supported research and utilization programs (such as solar water heating supplemented by gas heaters) to answering questions about what appear to be really unattractive economics in solar-based energy approaches.

The Auto-Adjust Turbo-Meter 26

The turbine meter for large volume natural gas measurement has many advantages, including rangeability, compact size, and simplified field maintenance. Now, another improvement has been added... a method that permits automatic adjustment of accuracy to initial calibration despite meter component wear, along with self-check of mechanical or electrical condition and advance warning of deteriorating condition well before meter failure might occur.

Ju'aymah Pipeline Trestle
Extremely Sophisticated Project 39

A six-mile-long concrete pipeline support trestle, costing $4.5 billion, has been installed in the Arabian Gulf at Ju'aymah using a very sophisticated computerized survey system and the latest technology in piledriving and pile-setting.



THE COVER

Aerial view of the Ju'aymah pipeline trestle in the Arabian Gulf; see page 39 for details on the trestle, a $4.5 billion facility that carries 36- and 48-in. insulated LPG pipelines.

—Photo courtesy Raymond International

FINANCIAL NOTEBOOK

Money Market, Mergers, Acquisitions, Executive Changes, Capital Expenditures

Company	Oil ($/Bbl) 1980	Oil ($/Bbl) 1979	Gas ($/Mcf) 1980	Gas ($/Mcf) 1979
C&K Petroleum[3]	$20.40[e]	$14.49	$2.05[e]	$1.93
Consolidated Oil & Gas	17.48	9.48	2.38	1.68
Dorchester Gas[1]	24.25	12.58	1.07	0.74
Energy Reserves Group	27.91	13.04	1.48	1.26
Forest Oil	17.74	11.53	1.65	1.40
General American Oil[2]	17.37	10.09	1.50	1.02
Lear Petroleum	27.70	15.90	2.43	1.68
Louisiana L&E	13.07	10.54	1.60	1.11
Mapco	22.96	12.23	0.87	0.52
McAlester Fuel Co.[3]	15.45	10.41	2.31	1.75
Patrick Petroleum[4]	19.57	10.07	1.74	1.66
Petro-Lewis	19.09	11.30	1.64	1.25
Southland Royalty	16.83	9.21	1.88	1.44
Superior Oil	16.55	9.06	1.58	1.20
Supron Energy	19.86	10.18	1.63	1.40
Triton Oil & Gas[2]	25.88	11.13	1.67	0.87
Williams Cos.[3]	13.57[e]	9.50	2.82[e]	2.28

[1] Quarters ended Feb. 29, 1979/80. [2] Nine months ends March 31. [3] 1979 figures are for full year. [4] Quarter ends Jan. 31. [e] Company estimate of whole year.

PRICE INCREASES FOR U.S. oil and gas during 1979 are reflected in this table. Prices are the average received by independent producers on U.S. sales for quarters ended March 31, 1979 and 1980, unless otherwise noted.

Average oil prices doubled in some cases while average gas prices rose on the order of 20% to 50%. Higher prices resulted from phase-out of controls on established oil production, higher federal ceilings on new gas production and decontrol of new oil and deep gas production.

INTERNATIONAL EXPLORATION CONTRACTS were inked by a number of Western oil firms. Union Oil of California and Inalruco S.A. of Argentina bid $20.5 million to win a 5-year risk contract for Llancanelo block in western Argentina. Project calls for some $20 million outlays to explore for heavy crude in more than 600,000 acres.

Occidental Petroleum signed agreement with Ecopetrol, state oil firm of Colombia, covering five blocks (some 12.3 million acres) in eastern Colombia. Oxy will drill four wells on each block during first year of 6-year contract. Ecopetrol will be 50% partner in any commercial oil discovery.

Unit of Coastal Corp. signed agreement with Libyan National Oil Co. to explore and develop oil reserves in 7 million acres in northeastern Libya. Coastal must drill 13 wildcats and will have production share ranging from 10% to 19%. If production is established, a 20-year contract will be signed.

Union Texas Petroleum (Dow Chemical), operator for three firms, signed an agreement with ETAP, state oil company of Tunisia, covering 1.8 million acres in north central Tunisia. Union Texas has 40%, AGIP (state oil firm of Italy) has 40% and Anadarko Production (Panhandle Eastern Pipeline) has 20%.

Compagnie Francaise des Petroles has agreement with Sonatrach, state oil entity of Algeria, to explore an area around Hassi R'Mel gas field over 4 years, with expenditures estimated at $52 million....Standard Oil (Ohio) units obtained interest in 900,000-acre tract near Algeria's El Borma field next to Tunisia.

CFP and Elf Aquitaine signed agreements with China's national oil entity to explore 7500 sq miles in China's Bay of Pohai and Gulf of Beibu. French firms will have 49% interest and China 51%.

ACQUISITIONS. Atlantic Richfield sold its 60% interest in Colony oil shale project to Exxon for $400 million. Tosco Corp. holds the other 40%. Earlier this year, Tosco said the $1.7 billion project, which has a final environmental impact statement, will begin as soon as Congress enacts synfuels legislation.

McMoRan Oil & Gas agreed to sell two subsidiaries representing all its Canadian oil/gas interests to Willowdale Resources Ltd. for $11 million...Crutcher Resources agreed to buy all common stock of KBM Well Service, Inc. (Williston, ND) for cash and notes. KBM operates 11 well servicing rigs rated to 15,000 ft in Williston Basin.

Crown Central Petroleum agreed to buy North Cristoval field in Texas, with five wells now producing 300 b/d oil, from Texcan Resources for $8.7 million

Henderson Petroleum agreed to buy interest in two deep gas wells in Custer County, OK, plus undeveloped acreage, for $800,000 and to buy Bixler Energy, Inc. (Denver) for 165,000 Henderson common shares. Bixler owns 20% interest in eight producing oil/gas wells in Okmulgee County, OK.

JOINT VENTURES. Units of McMoRan Oil & Gas formed two separate joint exploration ventures with major partners Transco Exploration and Freeport Oil over 3 years. McMoRan will have 37.5% interest in onshore Gulf Coast exploration and 35% offshore in Gulf of Mexico. In all, some $252 million will be spent.

Gulf Oil and Conoco, Inc. formed partnership to conduct a $73 million oil search in Williston Basin in Montana and North Dakota. Project will take 4 years and cover some 10,000 sq mi. Seismic and drilling already have begun.

Columbia Gas System's Canadian unit and four other Canadian firms plan a $60 million joint exploration on 18 million acres in Canada over 3 years. Columbia's share of outlays is $15 million. Other firms are Coseka Resources, Teck Corp., Clarion Corp. and Sulpetro Ltd.

Southern Natural Gas agreed to become equal partner with United Gas Pipe Line in proposed Trans-Anadarko Pipeline System, a 635-mile line from Texas panhandle to North Louisiana expected to cost about $400 million.

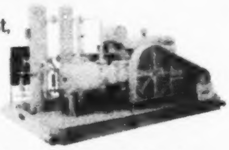
Joint venture of McCulloch Oil Corp. and Geothermal Kinetics, Inc. received $49.4 million geothermal loan guarantee from Department of Energy, largest yet granted by DOE. Venture will borrow funds from Bank of Montreal (California) and Bank of America to develop resources in California's Imperial Valley.

ARCO Chemical and Mitsubishi Petrochemical agreed to form joint venture for oilfield and refinery process chemicals business in Asia.

"Our portable KHB compressor from Ki has already paid for itself."

You might not think a portable 50 hp gas compressor could contribute much to your profit picture these days. But it can. We've used ours for short term well tests. And for generating income from low production wells which have been shut in till the economics became more favorable.

Ki's KHB belt driven horizontal compressor is skid-mounted for easy portability. It's available in one or two stage units for 25 to 75 hp service. Has a 5-inch stroke and is capable of 10,000 lbs. rod loading. Variable clearance cylinder heads make it easy to fine-tune performance or adjust compression to changing field conditions.



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When it comes to compressors, Ki does it all. And does it better.

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Capital Outlays Top $100 Billion

WORLDWIDE OIL/GAS INDUSTRY WILL SPEND more than a hundred billion dollars in 1980. Capital and exploratory outlays in 1980 will rise about 12%, according to our estimate. This could mean a zero "real" increase in constant dollars. Communist countries are excluded because data received are not comparable to company budgets.

National companies will spend little more on investment than they have in the past. With these firms it's hard to separate expenditures for oil/gas operations from those for, say, workers' housing. They branch out into many phases of the economy besides energy investments if their finances are in the black. This goes for national entities from Pemex to Pertamina.

Mitchell Energy & Development Corp. increased its capital budget for fiscal 1980 to $264 million from the $200 million set in December, 1979.

Shell budgeted $2.7 billion in 1980 for capital and exploratory spending. Kerr-McGee projects more than $500 million expenditures in 1980. Arkla Gas announced a $168 million construction and exploration program for 1980.

Sun Co. projects a $1 billion outlay for 1980 and in addition will spend $400 million developing Texas Pacific oil properties (bought from Seagram).

Atlantic Richfield plans to spend $3 billion this year, up from $1.8 billion invested in 1979; 71% is for U.S., mainly in Alaska, Texas and Louisiana.

Both Arco and Standard Indiana expect to increase overseas exploration and production. Standard Indiana will spend about $4 billion in 1980. Texaco boosted its 1980 budget by $500 million to $2.6 billion.

Approved by Exxon is a 1980 capital exploration budget of $7.5 billion compared to $6.859 billion in 1979. Gulf Oil approved a $3 billion budget for 1980.

Marathon says two-thirds of its $715 million capital and exploration outlays will go for developing reserves worldwide. American Petrofina plans a $105 million budget for 1980.

Large capital funds for synthetic fuels are projected for 1980/1--but Washington will supply most from oil taxes. Some will go outside the oil industry. Any company with an idea for synfuels has a chance to be financed by the Department of Energy.

Estimated Capital and Exploratory Expenditures for Oil/Gas Reserves and Facilities

(U.S. and Non-Communist Countries – Millions of Dollars)

	1979			1980[e]			1981[e]		
	USA[*]	non-USA	Total	USA	non-USA	Total	USA	non-USA	Total
Oil & Gas[1]	24,500	18,740	43,240	30,400	17,200	47,600	30,500	20,100	50,600
Manufacturing[2]	4,050	11,200	15,250	5,100	12,860	17,960	6,570	14,260	20,830
Marketing	1,700	2,100	3,800	1,170	2,400	3,570	1,350	2,740	4,090
Liquid Pipelines[3]	1,000	5,100	6,100	1,100	5,060	6,160	1,540	5,500	7,040
Marine Transport	3,200	7,010	10,210	3,700	6,700	10,400	4,170	7,400	11,570
Other Energy Resources[4]	4,050	3,700	7,750	4,660	4,040	8,700	5,010	4,810	9,820
Miscellaneous[5]	800	1,020	1,820	1,050	1,200	2,250	2,100	1,390	3,490
Sub Total	39,300	48,870	88,170	47,180	49,460	96,640	51,240	56,200	107,440
Gas Pipelines[3]	4,000	4,300	8,300	5,800	4,800	10,600	9,300	5,000	14,300
LNG/SNG[3]	700	2,000	2,700	630	2,220	2,850	450	1,000	1,450
Sub Total	4,700	6,300	11,000	7,020	6,430	13,450	9,750	6,000	15,750
TOTAL	44,000	55,170	99,170	53,610	56,480	110,090	60,990	62,200	123,190

NOTE: Most non-USA expenditures will be made by state-owned companies. It is difficult to draw a line between oil/gas operational costs and infrastructure costs. Refining has been neglected and outlays may be higher than estimated here. OPEC members have huge plans for refining and petrochemical complexes. Marine transport will grow mainly from government subsidies. Alternate energy resources will depend largely on government subsidies.

[1] Includes exploration expenses. [2] Refining and petrochemical plants owned by oil/gas companies. [3] PIPELINE & GAS JOURNAL estimates. [4] Coal, tar sands, oil shale, nuclear, solar, geothermal, biomass energy expenditures by oil/gas companies and governments, e.g., the U.S. Department of Energy has $2.2 billion for synfuel projects in 1980. [5] Energy-related investment. [e] Estimate.

[*] USA means in the 50 states – not USA Oil companies' outlays.

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ENERGY OPERATIONS & EQUIPMENT FORECAST

July 15, 1980

PIPELINE & GAS JOURNAL

—Photo courtesy of National Supply Co.

ABOUT THE COVER: Fossils ... the beginning. Oil and gas are fossil fuels that have supplied the bulk of energy used in industrial nations for the past 50 years. They'll play the same role for the next 50 years—until alternate fuels are on stream to replace them. Technology must be continually adapted to new methods of finding and developing oil and gas.

1 Overview of Oil/Gas Operations, Supply/Demand and Technical Advances

Energy Publications staff examines current and future trends in rig use, drilling/production technology, pipelining projects, U.S. gas supply and international oil/gas operations.

Boom Time for U.S. Drillers
by Rich McNally, Associate Editor, PETROLEUM ENGINEER INTERNATIONAL
Production Technology Is Never Static
by W.B. Bleakley, Editor, PETROLEUM ENGINEER INTERNATIONAL
Record Year Seen for Cross-Country Pipelines
by Dean Hale, Editor, PIPELINE & GAS JOURNAL
Gas Distribution Faces Expanding Future
by Norman S. George, Managing Editor, PIPELINE & GAS JOURNAL
World Prepares for Record Oil/Gas Development
by Gregory Martin, Editor, ENERGY NEWS/ENERGY WEEK

[illegible] Drilling/Production

New equipment, supplies and services in this section are a boon to drilling/producing/field processing operations in all kinds of climates and situations.

72 Cross-Country Pipelining/Gas Distribution

These products come in handy in pipeline construction/maintenance, SNG and LNG processing, gas distribution, leak detection, corrosion control, and measurement.

96 Multiple-Use Tools

New equipment and services in this section improve operations in more than one major division of oil/gas activity.

Front and Back—Inquiry Cards

Prepaid cards in front and back of this issue enable you to get information quickly on any equipment, supplies or services mentioned. Circle the number of the ad or item on one of the cards and mail it. Our computer center forwards your inquiry to the appropriate company.

Send me further details on items corresponding to code numbers circled below:

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020	040	060	080	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600

July 15, 1980 issue; Reader Service for this issue expires December 31, 1980

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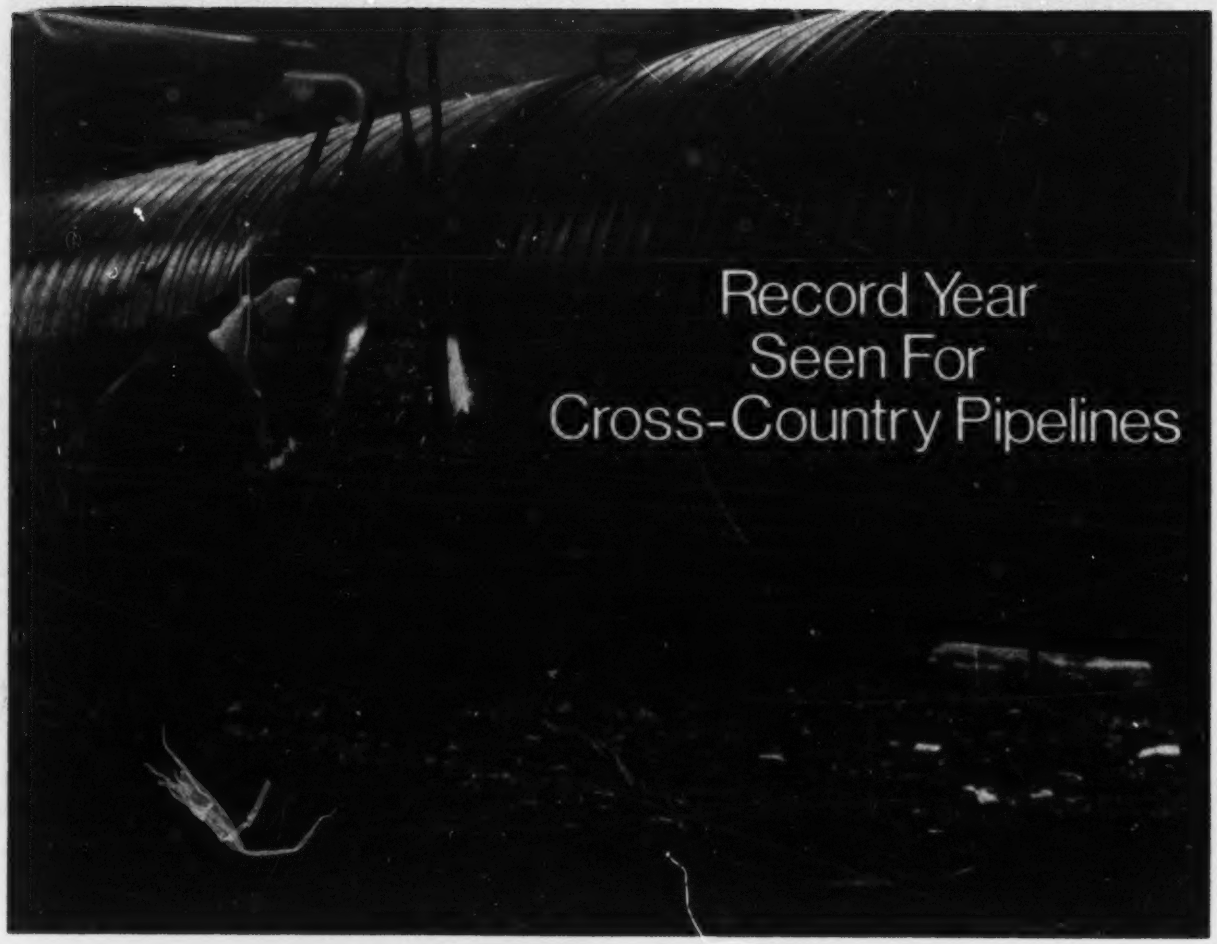


Record Year Seen For Cross-Country Pipelines

by **Dean Hale,** *Editor, Pipeline & Gas Journal*

With some 125,200 miles of oil and gas pipelines planned or under construction, the world pipeline business is expected to make 1980 another record year. Over $11.27 billion will be spent during the year to install more than 23,000 miles of crude oil, refined products, natural gas liquids, natural gas, and slurry pipelines. That figure includes 8,868 miles of cross-country pipelines in the U.S., at a cost of $3.12 billion, and 14,205 miles outside the U.S. at a cost of $8.15 billion.

No substantial decline in the demand for pipelines to move hydrocarbon energy is foreseen for the next decade, simply because the global demand for energy and for pipeline transportation will continue to increase.

The number of pipeline "super projects" planned or underway is also growing. Among the major projects being built are the Petroline east-to-west 48-in. line stretching 787 miles across Saudi Arabia for Petromin, and the companion and parallel 747-mile, 24- and 30-in. natural gas liquids line for Aramco. Progress on both lines is excellent — the pipelines are on or ahead of schedule and work has begun on the pumping station facilities and terminals.

Work is also getting underway this summer on the 746 miles of 4- thru 48-in. for the big Zadco gathering and delivery system offshore Abu Dhabi. Thailand's 266-mile 34-in. offshore gas line, plus 113 miles of onshore 28-in. pipeline to Bangkok, is to get underway by September 1. In Australia, engineering work is getting underway for initial design on the Dampier to Perth 34- to 36-in. gas line that will deliver gas from the North West Shelf to markets 860 miles away.

Moving slowly toward actuality, the Alaska Highway Gas Pipeline Project, which hopefully will deliver gas from Alaska's Prudhoe Bay to the "lower 48," has life in its branches. Work is expected to get underway in 1980 on the 160.5 miles of 36-in. for the western leg, first phase of a 911-mile, 36-in. loop of the existing Pacific Gas Transmission/Pacific Gas & Electric Alberta-to-California line. The eastern leg, 809 miles of 42-in. to be built by Northern Border Pipeline, is also planned for initial construction in 1980. And in Alberta, Foothills Pipeline and Alberta Natural Gas hopefully will get work underway on pre-build sections that will permit Alberta natural gas to flow through to U.S. markets until the gas from Prudhoe Bay begins flowing southward. Much of the final route selection for the 743-mile Northwest Alaska Pipeline section is now complete — and only about 299 miles of the 48-in. will parallel the trans-Alaska oil pipeline; the remainder will go a slightly different route (and it will nearly all be buried instead of being carried above ground on supports). Cost of the Alaska Highway Gas Pipeline Project, in total, is now estimated at over $23 billion.

In Canada, focus most recently has been on the proposals to deliver natural gas to Quebec and the Maritime provinces. Competing Q&M Pipelines and TransCanada PipeLines projects were combined, resulting in a plan to build 960 miles of main lines and laterals at a cost of $900 million

1980 Pipeline Construction
(Estimated Miles Completed During Year)

	U.S.	International	Total
Gas			
Transmission	3760	3490	7250
Field, Gathering, Storage	1200	1800	3000
Total	4960	5290	10250
Crude			
Trunk	1121	3080	4201
Gathering	640	1700	2340
Total	1761	4780	6541
Products			
Refined Products	907	1490	2397
LPG/NGL	560	1710	2270
Total	1467	3400	4867
Offshore			
Oil	194	710	404
Gas	486	525	1011
Total	680	735	1415
GRAND TOTAL	**8868**	**14205**	**23073**
Prime Movers			
(Estimated Horsepower Installed During Year)			
Compressor	323,000	808,000	1,131,000
Pump	255,000	380,000	635,000
Total	**578,000**	**1,188,000**	**1,766,000**

($300 million in Quebec, $600 million to expand TCPL's pipeline in the western provinces). Canada's Minister of Energy Marc Lalonde recently said the line to Quebec City would be built, but further extensions were being deferred. The Polar Gas Project has been reviewed again, and the project has another new plan—one that will require choosing from four competing proposals for the line that will reach into the High Arctic Islands and connect with a Y line extending west to the Beaufort Sea area and east to Melville Island.

In the U.S., products pipeline activity again dominates the construction scene. Mapco has awarded contracts for 1190 miles of 4- thru 12-in. lines from Rock Springs, Wyo. to Hobbs, N. Mex. to expand its natural gas liquids system. Santa Fe Pipelines has also announced for 1981 construction a 700-mile, $75 million 10- to 14-in. line from Hobbs, N.Mex. to the Gulf Coast near Houston. Other major products pipeline projects underway include Hydrocarbon Transport Inc.'s 210 miles in Kansas; Phillips Pipeline's 428-mile, 16-in. line from Borger, Tex. to Paola, Kans.; and Colonial Pipeline's 141 miles of 36-in. in Maryland and Delaware.

Crude oil pipeline activity was given a boost with the announcement that Wood River Pipe Line, a joint venture of Koch Oil and Williams Pipeline Co., would build 450 miles of 20- and 24-in. oil line from Wood River, Ill. to Bethany, Mo. to Mason City, Iowa. Work is underway. Pacific Coast Pipe Line, a new firm headquartered in Houston, announced plans to build a $1.3 billion, 1,107-mile, 36-in. line from near Taft, Calif. to Midland, Tex. Project does not include a lateral to coastal port, but that could be added in the future. Northern Tier Pipeline's proposed 1,491-mile, 40- and 42-in. system from Port Angeles, Wash. to Clearbrook, Minn. is in the final stages of clearing out the permitting process and arranging financing; proponents are hopeful of having a green light for the project by late autumn.

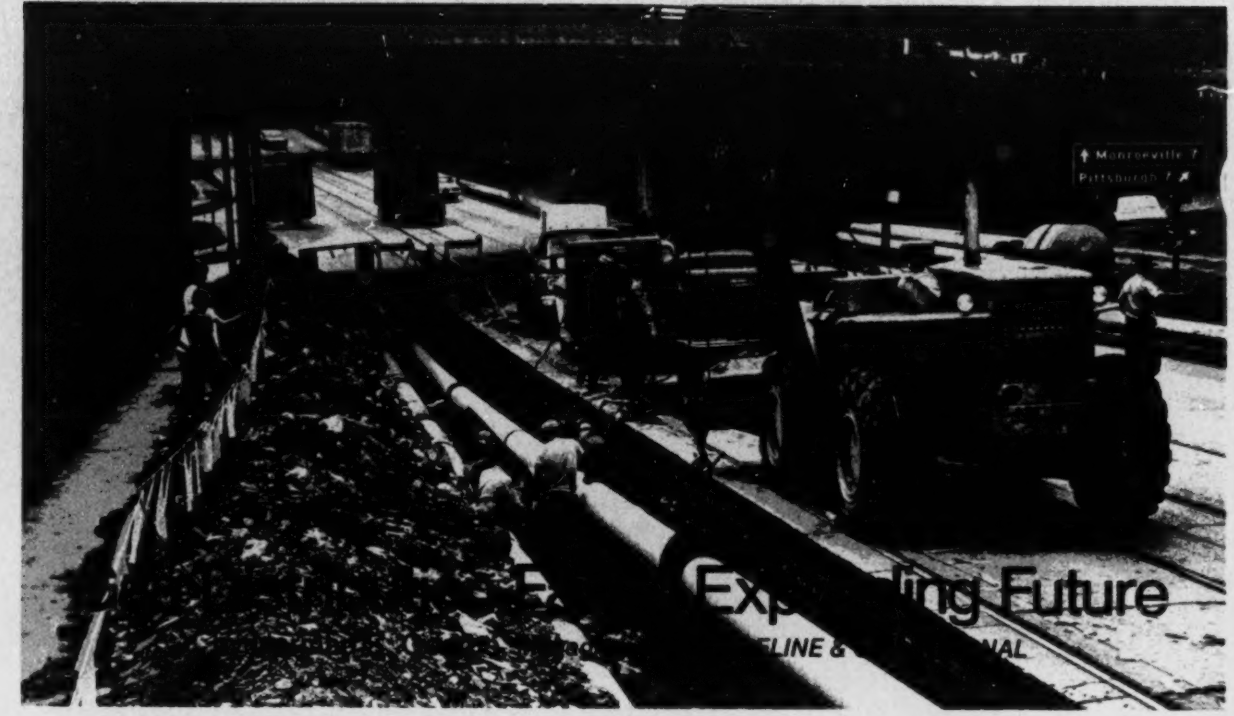
Major gas pipeline projects on the books include the 695-mile, 36-in. Rocky Mountain Pipeline from the Rocky Mountain Overthrust Belt area to California; the Trailblazer project from the same area to the Midwest, involving 840 miles of 30- and 36-in. pipe, and the Trans-Anadarko Project from western Oklahoma and the Texas Panhandle to Louisiana (United Energy Resources), involving 635 miles of 30- or 36-in. pipeline. Also planned are 115 miles of 30-in. loops by Texas Eastern, 163 miles of 16-in. in Texas by Northern Natural Gas, and 440 miles of 20-in. by Ozark Gas Pipeline Corp. in Oklahoma, Texas, and Arkansas

Internationally, the spotlight most recently has fallen on Brazil, where Petrobras has awarded a contract for 280 miles of offshore 12- to 24-in. line in the Campos Basin, 200 miles northeast of Rio de Janeiro, that is to be completed by early 1984. Another 60 miles is reportedly still planned. Cost is $95 million. In the United Kingdom, British Gas Corp. has awarded contracts on about one-half of the 280 miles of 42-in. to be built from St. Fergus, Scotland to Bishop Aukland. The 1980 work includes an 11-mile crossing of the Firth of Forth and a 4.7-mile crossing of the River Tay.

In the North Sea, only about 98 miles of 16-, 18-, and 24-in. line are planned—involving four different fields. Continuing studies are being made on proposals for a 625-mile, large diameter (at least 36-in.) gas line from Statfjord to the northern European coast. The Middle European Gasline (MEGAL) system is to be operational by the end of 1980 with completion of facilities in France, West Germany, and Austria. The Trans-Mediterranean Pipeline, stretching 1500 miles from Algeria's Hassi R'Mel field to northern Italy via Tunisia and Sicily, is well on or ahead of schedule on all sections. All three lines across the Sicilian Strait will be installed this year (each is 20-in., 100 miles long, laid to a depth of 1,995 ft at the deepest point).

With Algeria's Sonatrach apparently moving away from export of LNG, the SEGAMO gas line proposal involving 600 miles of pipeline across the Mediterranean from Algeria to Spain and France remains alive. A new plan reportedly will surface on this project in late 1980 or early 1981. Sonatrach is also reportedly ready to award contracts on two major gas pipelines, one a 318-mile, 42-in. line from Hassi R'Mel to Arzew, the other a 620-mile, 42- and 48-in. line from Alrar to Hassi R'Mel.

And, finally, the capacity of the SUMED oil pipeline running parallel to the Suez Canal may be greatly increased at the request of Saudi Arabia. When the east-west Petroline is completed, greatly increased amounts of crude may move from Yanbu to the SUMED southern terminal for transit to loading at the Mediterranean terminal. Such a capacity increase would almost certainly require additional pipeline construction.



[illegible] Ex[illegible] Exp[illegible]ing Future

[illegible] [illegible]ELINE & [illegible] [illegible]NAL

Unflickered by the downturn experienced by some U.S. industries, America's blue flame burns even brighter, fanned by strong supply and demand for gas, record-breaking expenditures to accommodate both, and increased maintenance budgets to keep the nation's 1.3 million miles of gas distribution mains and services in good working order.

There's a ripple effect from all this—for once, positive—and the industry's equipment manufacturers and suppliers are enjoying the sensation.

That ripple has been noted at the top and confirmed by PIPELINE & GAS JOURNAL'S market research group (May P&GJ, pp. 20-22). American Gas Association anticipates more than $300 billion in gas industry expenditures between 1979 and 2000, of which a projected $88 billion—more than $4 billion annually, excluding the cost of the Alaska Gas Pipeline—will go into construction and maintenance of cross-country gas pipelines and utility mains and services.

A recent P&GJ study shows that the industry plans 349,000 miles of all types of lines before 1990 and will spend more than $70 billion to build them; in the distribution field, $33.7 billion is estimated for construction of 293,000-plus miles of mains and services in the next 10 years.

Budget figures lead to the conclusion that more people want gas, that the required extensions will cost more money—and that inflation is having its effect. Other figures are worth examining:

Demand statistics, even with a slump in new housing construction, still managed to register the sharpest rise in 30 years, according to A.G.A., and indicate sustained market growth in 1980. The Association expects 700,000 new hook-ups this year (there were 550,000 in 1979), increased gas sales to industry (up 14% last year), and growing numbers of residential customer conversions from oil to gas (225,000 in 1979, up 59%).

Gas supply will meet that demand. Dr. Henry Linden of the Gas Research Institute says the U.S. has enough for 40 years at current consumption rates, likely to increase to 65 to 70 years with renewed drilling. The U.S. gas industry added 14.3 trillion cubic feet of reserves in 1979, up 35% over 1978, and although there is still a gap between additions and current domestic production—about 5.5 Tcf last year—industry experts believe that Overthrust Belt and Alaskan volumes will eventually make up the difference.

Peakshaving gas supplies are ample—69.86 billion cu ft as underground gas storage, propane-air, peakshaving LNG, and other supplemental fuels during winter 1979-80, up from 68.62 Bcf the year before—and were especially so given the mildness of the last heating season. Major U.S. utilities such as ANR Storage Co., National Fuel Gas Corp., Washington Natural Gas Co., and others will spend more than $285 million in 1980 for underground gas storage and related facilities.

Plastic pipe sales and usage continue to increase, clearly dominating the new and replacement pipe market. This year, 78% of all distribution piping will be plastic, a remarkable figure in a field once held by steel pipe and tubing (only 12% of that field was plastic in 1966). More and more utilities report using plastic, especially polyethylene, as their primary distribution material. According to P&GJ's latest survey, 95.1% of all U.S. companies will use the material in 1980.

U.S. GAS DISTRIBUTION PIPING—1980-1989

Projection	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Miles of Gas Mains Installed	13,448	14,000	14,900	14,800	14,400	14,600	14,200	14,200	14,700	15,100
Miles of Gas Services Installed	13,798	14,000	14,200	14,600	14,700	15,000	15,600	15,550	15,900	15,900
Total	**27,246**	**28,000**	**29,100**	**29,400**	**29,100**	**29,600**	**29,800**	**29,750**	**30,600**	**31,000**
Construction Expenditures, Distribution ($Billion)	1.781	2.049	2.381	2.646	2.987	3.402	3.870	4.299	4.872	5.370

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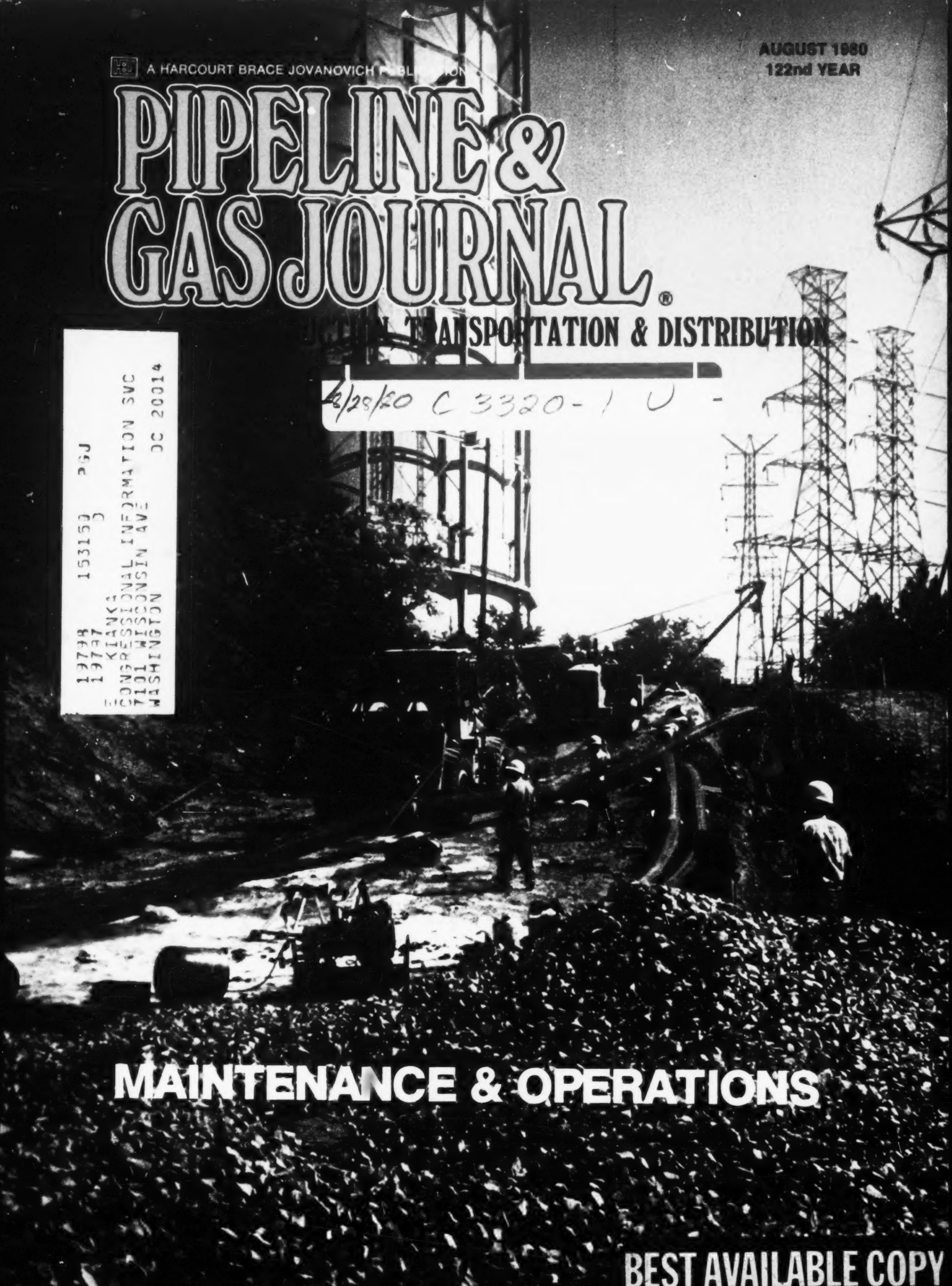

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THE COVER
Workmen prepare 12-in. PE plastic pipe for insertion into 16-in. C.I. main as a river crossing pipe replacement. Story on page 19.

—Photo courtesy Public Service Electric & Gas Co.

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River Crossing Replaced With Plastic . . . 19

Public Service Electric and Gas Co., faced with having to repair or replace a pair of 16-in. cast iron pipe river crossings, elected to line them with 12-in. plastic inserts, using ultra-high molecular weight, high density polyethylene pipe.

System Replacement By Insertion 22

Michigan Consolidated Gas Co. began a program in the early 1970's of area renewals of its low pressure cast iron systems; the program has spread from the downtown Detroit area outward into suburban areas and is expected to accelerate in coming years.

Quick & Easy Service Replacements 25

Northern Illinois Gas Co. has developed a replacement method, developed for its copper tubing services that had to be replaced, in which the old copper service is removed by pulling and a new one installed in the same space, using a plastic-aluminum composite (PAC) tubing or polyethylene plastic tubing.

Vacuum Excavating 32

Citizens Gas & Coke Utility of Indianapolis is reducing operating costs and speeding the abandonment of inactive services by using a technique involving a vacuum excavator, one-foot square excavations, and specialty tools.

AGTL Testing Pipeline Inspection Pigs . . 43

How good are the electromagnetic pipeline inspection tools in detecting pipeline corrosion and mechanical damage? Alberta Gas Truck Line Co. Ltd. has a full-scale evaluation program underway to find out.

Dow Initiates Damage Program 46

Intensive "check before you dig" educational program implemented by Dow and its pipeline operations is aimed at preventing damage to pipelines by outside contractors.

Band Repair Clamp For Plastic 50

Ordinarily, damage to buried plastic pipe requires repair by replacement, regardless of amount of damage; Wisconsin Gas Co. research has helped develop a suitable stainless steel, full-encirclement band clamp for use as a permanent repair when the plastic pipe has only limited damage.

What's New in Repair/Maintenance 58

Latest ideas in materials and equipment for use in keeping facilities operating and in good order in both pipeline and gas distribution utility operations with full details available by simply using this issue's *Reader Service Card.*

New Approach For Odorization 62

Precise odorization control is now being used by Northwest Pipeline Corp. on three of its laterals to city gate stations; system uses vortex-shedding flowmeters to keep odorant injection rate proportional to the gas flow rate in the pipeline.

AN ENERGY MANAGEMENT NEWSLETTER

FINANCIAL NOTEBOOK

Money Market, Mergers, Acquisitions, Executive Changes, Capital Expenditures

Acquisitions. *Sun Co.* acquired *Viking Oil Ltd.* (London) for $33.4 million. Viking's main asset is 20% interest in certain North Sea oil/gas blocks.

Gulf Oil agreed to sell its 45% interest in *Okinawa Sekiyu Seisei*, which operates a 100,000 b/d refinery, to *Idemitsu Kosan* of Tokyo. Idemitsu now will own 90% of the refinery.

Nugget Oil Corp. agreed to acquire *Chaparral Energy Development Corp.* for 2.9 million common shares worth about $5 million.

Monument Energy Corp. agreed to acquire 80% interest in *Farmington Well Service*, which operates 12 rigs in Four Corners area of Southwest. Monument has 4-year option to acquire the remaining 20%.

Texas American Energy Corp. (Midland) agreed to buy *Western Kentucky Gas Co.*, an intrastate gas distributor, for about $23 million.

Briefs. U.S. *Export-Import Bank* okayed a loan of $4 million at 9%/yr to Blockfor, an Argentine firm, for purchase of a $9.3 million drilling rig from *Dresser Industries*. Blockfor is joint venture of *Astrafor* (Buenos Aires) and *Blocker Energy Corp.*

TOTAL (Cie. Francaise des Petroles) signed production sharing agreements with *Sonangol*, state oil concern of Angola, for a 4800-sq-km offshore block, and with *Petroci*, state oil concern of Ivory Coast, for a 6000-sq-km block partly onshore and partly on continental shelf.

Williams & Associates Security Consultants opened an Executive and Public Figure Protection Academy in Castle Rock, CO. offering courses in anti-kidnapping systems, evasive driving, movement security measures and defensive firearms tactics.

Rial Oil Co. holders approved a name change to *Sage Energy Co.* and an increse in shares from 5 million to 20 million.

Pecten Arabian Ltd. (Shell Oil) and *Saudi Basic Industries Corp.* (SABIC) agreed on terms for new $3 billion petrochemical complex to be built at Jabail Industrial City, Saudi Arabia. Complex is scheduled to be in operation late in 1985.

Proposal for construction of $3 billion in petrochemical plants was made to State of Alaska by *Dow Chemical Co.* Other companies involved would be *E.I. duPont de Nemours*, *Shell Chemical* and *Asahi-Dow* (Japanese affiliate of Dow Chemical). Construction project could create 2500 new jobs and $600 million additional taxes and royalty income to Alaska.

Pertamina, Indonesian oil monopoly, said *UOP Inc.* will provide engineering design to expand capacities in two Indonesian refineries in Java and Kalimantan by 200,000 b/d each.

Gasoline prices around the world in table below are from *ENERGY WEEK*, a sister newsletter publication. Write Brenda Norris, Box 1589, Dallas, TX 75221 for free sample copy.

Money markets. *Amarex, Inc.* privately placed $60.5 million of 12% non-recourse secured notes,

INTERNATIONAL FUEL PRICES per U.S. gallon FOR VEHICLES AT THE PUMP

Country	Regular		Premium[1]		Diesel		Unleaded	
	Price[2]	Taxes	Price[2]	Taxes	Price[2]	Taxes	Price[2]	Taxes
Austria	$2.30	$1.22	$2.51	$1.22	$2.31	$1.09		
*Bangladesh	2.02	0.27	2.07	0.29	0.74	0.07		
Belgium	2.91	1.52	2.98	1.52				
*Belize	1.355	0.224	1.435	0.223	1.225	0.10		
*Bermuda	1.94	0.57	2.07	0.57	1.29	0.076	none	none
*Brazil	2.35	0.24	3.49	0.32	1.03	0.09		
Britain	2.29	0.99	2.33	0.99				
Bulgaria	4.32							
Cameroon, Yaounde	2.22	0.44	2.40	0.48	1.87	0.44		
*Canada, Ottawa	0.82	0.248	0.917[3]	0.254[3]	0.833	0.286	0.875	0.248
*Colombia, Bogota	0.725	0.248	0.906	0.305	0.725	0.19	none	none
*Cyprus, Nicosia	2.59	0.97	2.83	0.97	0.99	none	none	none
Czechoslovakia			2.65					
*Denmark	3.41	1.99	3.45	1.99	1.94	0.56		
Dubai, UAE	1.39							
*Ecuador	0.18	0.06	none	none	0.14	0.01	none	none
Egypt	0.69							
*El Salvador	1.97	0.257	2.04	0.257	1.26	0.0258		
*Finland	2.76	1.08	2.88	1.04	1.95	0.62		
*France	2.97	1.70	3.17	1.81	2.23	1.035		
*West Germany	2.49	1.25	2.60	1.26	2.49	1.19		
East Germany	3.43							
*Greece	2.69	1.14	2.99	1.34	1.09	0.14		
*Rep. of Honduras	1.635	0.20	1.775	0.20	0.905	0.025	none	none
Hungary	2.60							
*Iceland, Reykjavik	3.57	1.98			1.39	0.03		
*India	2.07	1.18	2.15	1.18	0.74	0.21		
*Indonesia	0.606		0.848		0.212		none	none
*Iran	0.54		0.67		0.135			
*Ireland	2.64[4]	1.08	2.69[4]	1.08	2.19[4]	0.63		
*Israel	2.89		3.07		1.20			
*Italy	3.12	1.91	3.19	1.92	1.49	0.30		
*Jamaica	2.12	0.79	2.16	0.79	1.21	none	none	none
Japan	$2.[illegible]5							
Kenya, Nairobi			$2.78					
Luxembourg	2.28	$1.03	2.33	$1.03				
Netherlands	2.60	1.44	2.67	1.44				
*New Zealand	1.74	0.50	1.80	0.50	$1.22	$0.03	none	none
*Nicaragua	1.98	0.824	2.25	1.042	1.180	0.056		
*Pakistan	1.70	0.72	1.99	0.67	1.07	0.24		
*Philippines	1.41	0.53	1.51	0.58	0.85	0.11		
Poland	2.10							
*Qatar	0.234	none	0.394	none	0.159[5]		none	none
*Romania	2.46		2.65		2.08			
*S. Africa	2.40	0.575	2.46	0.577	0.70	0.485		
Spain[e]	2.68		3.12		1.17			
*Sweden	2.32	1.25	2.36	1.25	1.04	0.10	$2.38	$1.25
Switzerland	2.66	1.34	2.68	1.34				
*Taiwan	1.47	0.21	1.58	0.25	0.74	0.10		
*Thailand	1.38	0.57	1.45	0.60	0.89	0.13		
*Trinidad & Tobago	0.25	0.03	0.34	0.06	0.29	0.02		
*Turkey	2.33	0.28	2.65	0.33	0.95	0.18		
U.S.S.R.	2.85[6]							
U.S.A.[7] Full-Service								
New England	1.227	0.13	1.306	0.13			1.270	0.13
Mid Atlantic	1.257	0.13	1.324	0.13			1.296	0.13
Great Lakes	1.280	0.133	1.318	0.133			1.320	0.133
Midwest avg.	1.254	0.124	1.322	0.124			1.295	0.124
Southeast avg.	1.246	0.12	1.304	0.12			1.283	0.12
Southwest avg.	1.206	0.107	1.288	0.107			1.244	0.107
West avg.	1.268	0.12	1.313	0.12			1.304	0.12
Overall avg.	1.256	0.123	1.312	0.123	1.136		1.295	0.123
Gasohol avg.	1.291							
*Uruguay	3.25	1.23	4.07	1.62				
Yugoslavia	2.80							

*Official source. [1] Unleaded or leaded premium gasoline. [2] Price includes taxes. [3] Unleaded. [4] Also includes 10% Value Added Tax (VAT). [5] Private use price 15.9¢; commercial price 56.2¢/gal. [6] Estimate. Not based on official exchange rates. [7] American Auto Association (AAA) figures for price/gal. [e] Estimate.

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with 10% net profits royalty interest to be paid out of the company's interest in three private drilling programs.

Tucker Drilling Co. sold 450,000 common shares for about $4.6 million through underwriters led by Rauscher Pierce Refnes.

Summit Energy Inc. sold 600,000 convertible preferred shares for $12 million .... *Brady Energy Corp.* filed offer of 1 million preferred shares, each convertible into 4 common shares or exchangeable for net revenue from sale of 4 bbl of heavy oil from the firm's Alberta property.

Toledo Mining Co. sold 71,119 common shares of American Resources Management Corp. for $3.4 million. Toledo Mining acquired the shares in May 1978 when ARMC bought certain oil/gas leases in Colorado from TM.

India will buy Canadian oil and natural gas exploration equipment and services with a new $15 million (Cdn.) line of credit extended by the *Canadian International Development Agency*. The agency (handles Canada's foreign aid) said money is interest free and repayable over 50 years.

Crystal Oil is offering $35 million in subordinated debentures due July 15, 2000 through *Smith Barney, Harris Upham & Co.* and *E.F. Hutton & Co.* ... *Amarex Inc.* will sell $30 million in sinking-fund debentures due 2000 through *Donaldson, Lufkin & Jenrette Securities Corp.*

Armco Inc. will sell to sell the 1.9 million shares of $2.4375 cumulative convertible preferred stock of *Rowan Cos.* it acquired two years ago. Each preferred share is convertible into about 1.43 Rowan common shares.

Drilling programs. *McCormick Oil & Gas Co.* sold its 1980 drilling program for $24 million. Company and its corporate partners will make additional investments bringing to $31 million the amount available to drill about 30 prospects this year.

American Quasar Petroleum Co.'s Can-Am Drilling Programs Inc. unit closed its 1980-2 limited partnership at $40 million .... *Wainoco Oil Corp.'s* 1980 limited partnership was fully subscribed at $25 million. Operations will include some 50 prospects, most in U.S. Gulf Coast area.

Marline Oil Corp. completed a $16 million drilling fund with private investors .... *Nugget Oil Corp.* and *Rainy River Resources, Inc.* closed $840,000 offering on their 1980-1 drilling program.

Callon Petroleum Co. sold $12 million interest in a new limited partnership that will acquire royalties and mineral rights but won't drill wells. Callon will make another offering of up to $15 million in a similar royalty program for institutional investors.

General Electric Credit Corp. extended a $2.5 million loan to *CFI-Nevada 1979*, a California limited partnership, to underwrite drilling of some 20 wells in U.S. Southwest and Rocky Mountains.

Dyco Petroleum's second 1980 exploration offering of $25 million closed fully subscribed. It was the largest single offering in Dyco's history.

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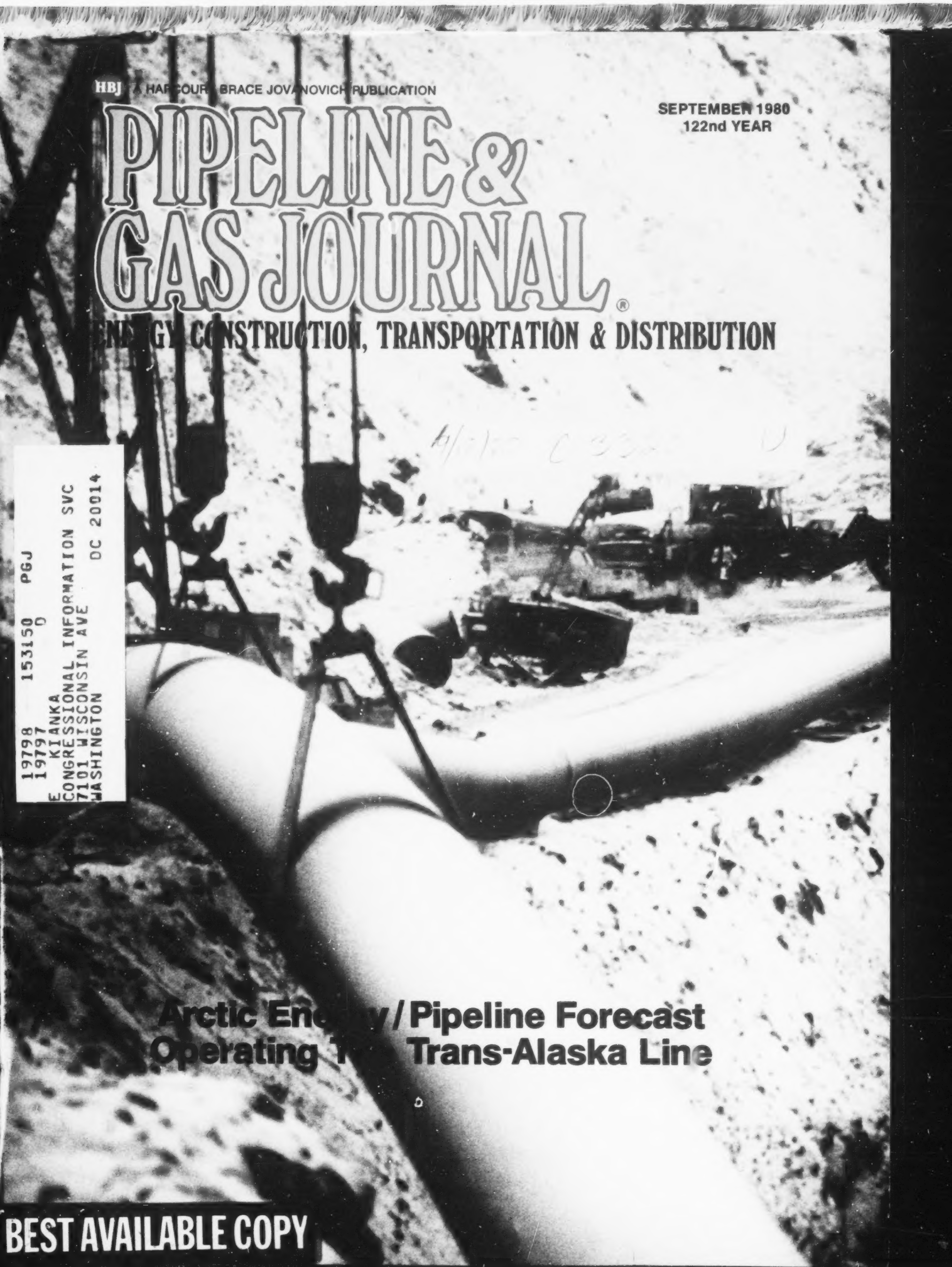

Arctic Energy/Pipeline Forecast
Operating The Trans-Alaska Line

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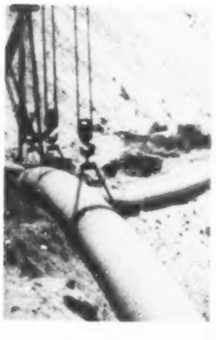

THE COVER

This year, America's eyes turn to the North as industry mobilizes to bring more Arctic Energy to eager markets in the Lower 48. Harsh environment, long nights, and permafrost will be overcome again — as they were here.

— courtesy Alyeska Pipeline Service Co.

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The regulatory logjam seems to have cleared, and nightmares about moving Alaskan gas to the Lower 48 can now become pleasant realities. Inside, a summary of progressing plans to tap Arctic energy.

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Operators in the Lower 48 have not had to worry about isolated, remote stations and camps, survival training, search parties, white-outs, limited availability of personnel, and adverse publicity about living conditions. Alyeska has.

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Silver Bay, Minn., at the northern end of Northern Natural's pipeline system, may be a small community — but it boasts a modern city gate station and state-of-the-art gas metering whose rangeability increases with line pressures.

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Are they the right answer to vehicular traffic-caused stress and corrosive attack? Panhandle Eastern investigated to come up with a modern solution to the old problems.

What's New In Meters And Measurement Equipment? 56

Lots — but the trick is in keeping up with it. Inside, 23 useful products to help make the most of every MCF and barrel through accurate, reliable metering, recording, proving, and sensing.

Canadian Gas Co-op Assembles Own Equipment Spread 63

There are 76 independent gas cooperatives in Alberta, each formed to supply abundant, relatively inexpensive gas to rural areas and towns. One, St. Paul Lakeland, owns its own pipeline spread.

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It began four years ago, when Congress got out its meat-axe to "get" wealthy American movie stars, lawyers, and businessmen who worked overseas for short periods. Now, the effect has been devastating to the construction and oil industries ....

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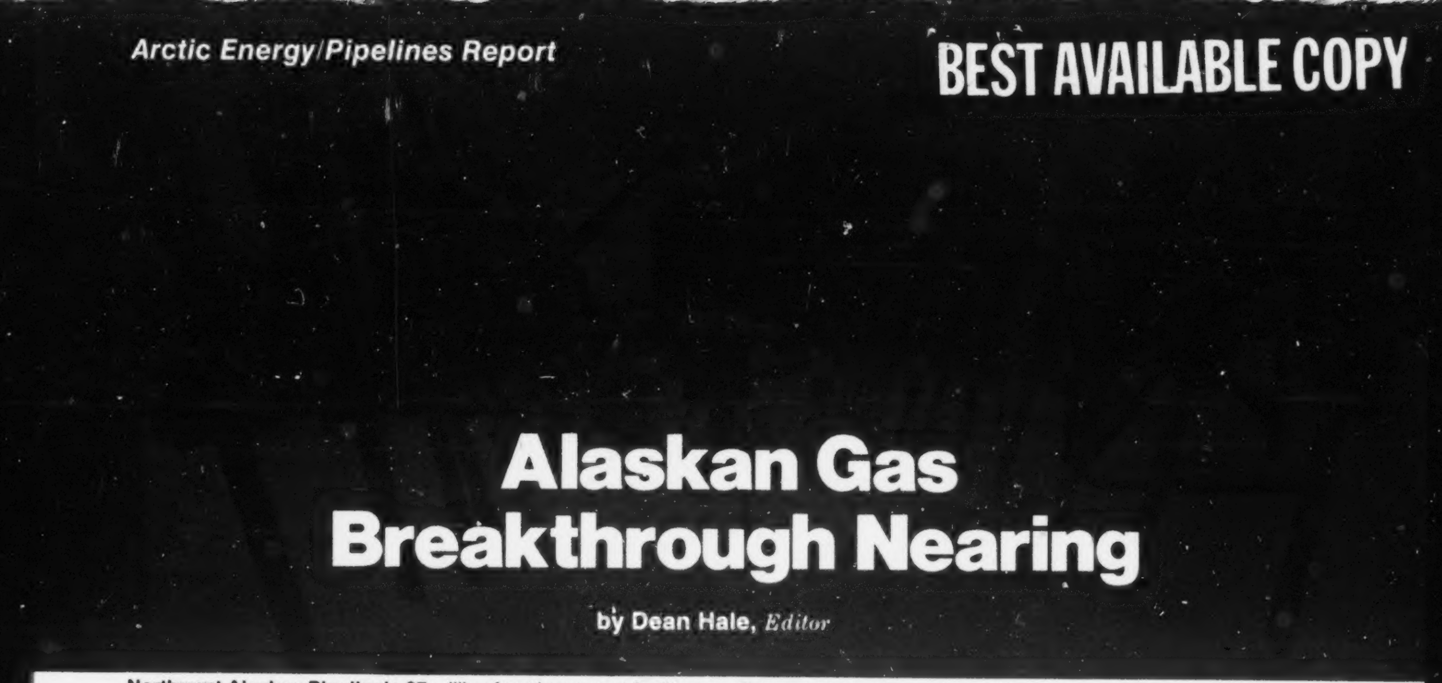

Alaskan Gas Breakthrough Nearing

by **Dean Hale**, *Editor*

Northwest Alaskan Pipeline's $7 million frost heave test facility near Fairbanks is testing various mitigative measures proposed to control frost heave encountered in permafrost regions. Chill pipes keep the test site ground frozen year-around to simulate conditions along the pipeline route.

With construction underway on segments of the prebuild sections of the 4800-mile Alaska Highway Gas Pipeline Project, the regulatory logjam appears to have been broken and nightmares about moving Alaskan gas to the lower 48 states can now turn to pleasant realities.

All necessary regulatory and government approvals in the U.S. and Canada were granted in mid-summer for early construction (pre-building) of certain portions of the overall system — in advance of the Alaskan section — to permit delivery of surplus Canadian gas to U.S. markets.

Portions being prebuilt are integral parts of the overall delivery system for Alaskan gas, and will involve construction of some 1888 miles of pipeline in the U.S. and Canada in the remainder of 1980 and during 1981. Prebuild sections in the U.S. will cost over $1.5 billion and will comprise the largest pipeline project ever installed in the lower 48 states.

Over 1 Bcf of Alberta natural gas will be transported per day for six years to U.S. markets. That includes up to 300 MMcf per day to be delivered to Southern California through the western delivery system and up to 800 MMcf per day to be transported through the U.S. eastern leg (Northern Border Pipeline) for midwestern, southern, and eastern U.S. markets.

The stage was set for the prebuild construction when the Federal Energy Regulatory Commission in June approved the western delivery system and issued a final order approving the Northern Border pipeline system. Approval by the Canadian government came in mid-July on the prebuild plan and for the required gas exports. Canada moved quickly for approval after being given assurances (in the form of a joint Congressional resolution) from the U.S., along with producer-sponsor agreements to fund final design and cost estimation and to negotiate a private financing plant.

Advantages of early pre-building, project spokesmen point out, are that the facilities added now will avoid higher inflationary costs of a later date, and earlier depreciation of facilities will result in a reduction of rate base and cost of service when Alaskan gas finally comes on stream. The total construction program will also be spread out over a greater period of time, lessening the impact of the project on availability of materials, equipment, capital, and manpower.

The $2.04 billion prebuild program involves 1888 miles of pipeline, including 555 miles in Canada — 132 miles on the western leg now and 28 miles within three years, plus 395 miles on the 42-in. eastern leg; plus 821 miles of 42-in. for the Northern Border system; 161 miles of 42-in. loops on Pacific Gas Transmission's system in Idaho, Washington, and Oregon; and 351 miles of 30 and 24-in. loop on Northwest Pipeline Co.'s system to permit handling 300 MMcf per day for delivery to Southern California via El Paso Natural Gas Co.'s pipeline system.

Plus A Touch of "1984" ...

Those who recall George Orwell's *1984* will shudder a bit when they hear what the federal government has planned for the pre-builders of the eastern and western legs: The "Federal Inspector" will have, effectively, control over nearly all decision-making — such as price, material selection, facility design, specifications, bidders' lists for materials and equipment, etc. *ad infinitum*.

In effect, the Federal Inspector will also serve as a one-window interface with all other Federal agencies — and some state agencies — with respect to the building of the overall Alaska Highway Gas Pipeline Project, and that includes the so-called eastern and western legs.

While it will, undoubtedly, be a king-sized headache for the pipeliners who will build the prebuild sections, it will "serve as good experience" for members of the Federal Inspector's team who will later oversee building the Alaskan section of the project.

Prebuild Details

Construction of the western and eastern legs of the prebuild sections of the Alaska Highway Gas Pipeline Project in Canada and the U.S. during the period 1980-81 will involve laying 1888 miles of pipe at an estimated cost of $2.04 billion.

The pre-build sections, to be utilized for the transportation of Alaskan gas to the lower 48 states beginning late in 1985, will initially provide for export of some 1.14 billion cu ft a day of Alberta gas to western and mid-western U.S. markets, rising to possible peak flows of 1.35 Bcf daily between 1983 and 1986.

In Canada, the pre-build sections will extend over a distance of 850 km (526 miles), cost an estimated $562 million, and require some 300,000 tons of 36 and 42-in. pipe. Estimated total value of materials and services required for

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Moving Arctic Energy To Market

Status of Projects and Proposals—September 1980

Type	Name	Size and Miles	Location	Status
Oil	Trans-Alaska Oil Pipeline	801 miles, 48-in.	Prudhoe Bay to Valdez	Completed and operating.
Oil	Northern Tier Pipeline Co.	1557 miles, 40 and 42-in.	Port Angeles, Wash. to Clearbrook, Minn.	Federal approval and all state approvals but Washington received; financing and permitting underway.
Gas	ALASKA HIGHWAY GAS PIPELINE PROJECT			
	Northwest Alaskan Pipeline Co.	743 miles, 48-in.	Prudhoe Bay to Alaska-Canada (Yukon) border	Final application for construction certificate made to FERC; expect approval by March 1, 1981
	Foothills Pipe Lines (South Yukon) Ltd.	232 miles, 48-in. 276 miles, 56-in.	Southern Yukon	Expect Canadian federal approval when Alaskan section is approved.
	Foothills Pipe Lines (North B.C.) Ltd.	444 miles, 56-in.	Northern British Columbia	Expect Canadian federal approval when Alaskan section is approved.
	Foothills Pipe Lines (Alberta) Ltd.	394 miles, 56-in. 234 miles, 42-in. 187 miles, 36-in.	Alberta	Expect Canadian federal approval when Alaskan section is approved. Prebuild sections involving 77 miles of 36-in. and 234 miles of 42-in. approved.
	Foothills Pipe Lines (South B.C.) Ltd.	105 miles, 36-in.	Southeastern B.C.	Approval given for prebuild construction underway on 55 miles of 36-in.
	Foothills Pipe Lines (Saskatchewan) Ltd.	161 miles, 42-in.	Saskatchewan	Approval given for prebuild; construction to get underway by spring 1981.
	Northern Border Pipeline Co.	821 miles, 42-in.	Monchy, Sask. to Ventura, Iowa	FERC approval given; construction to get underway in spring 1981.
	Pacific Gas Transmission Co.	160.5 miles, 42-in. in four loops.	Idaho, Washington, Oregon	FERC approval given on initial loop prebuild; construction to begin by
	Pacific Gas Transmission Co. and Pacific Gas & Electric Co.	721 miles, 36-in. and 42-in.		Awaiting FERC approval.
	Northwest Pipeline Co.	100 miles, 30-in. 10 miles, 24-in.	Oregon, Idaho	Approval given for prebuild construction; construction on loop underway.
		241 miles, 24-in.	Idaho	Loop on existing system; awaiting construction contracts.
	Foothills Pipe Lines	740 miles, 34-in.	Near Whitehorse to Mackenzie Delta area	Proposed; estimated cost $2.5 billion as of June, 1979.
	POLAR GAS PROJECT	2838 miles, 36 and 42-in.	High Arctic Islands and Mackenzie Delta to southern Canada	Project plans to file new application with National Energy Board by end of June 1981 for new "Y"-line.

construction of the two legs in Canada will amount to some $527 million.

Western Leg in Canada

Initial pre-building of the western leg involves installation of 215 km (132 miles) in seven loops on the existing Alberta Gas Trunk Line system in Alberta and on Alberta Natural Gas line in southern British Columbia. An additional 45 km (28 miles) of loops are to be added to the western system in 1983. All pipe is 36-in. No new compressor facilities will be required.

Construction of the loops will provide capacity for the export of Alberta gas through the pre-build facilities of up to 240 Mmcf per day between 1980-81 and 1981-82 and up to 300 Mmcf per day from 1983-84 to 1986-87. The pre-build system will transport gas from James River, Alberta, 100 km (60 miles) north of Calgary where the main line divides. The western leg runs southwest to Kingsgate, the B.C.-Idaho border point where it will join with the western leg facilities of Pacific Gas Transmission Co.

Total length of the system in Canada is 472 km (292 miles).

The loops, being built by Foothills Pipelines (Alta) Ltd. in Alberta and Foothills Pipelines (South BC) Ltd. in British Columbia, will eventually be filled to provide a continuous western leg pipeline for moving Alaskan gas to the western United States.

The three loops to be installed in Alberta are:

- James River to Elkton Creek, 33.3 km (20.2 miles)
- Cochrane-Elbow River area, 46.8 km (28.5 miles)
- Chain Lakes Park to Old Man River, 44 km (26.5 miles)

The four loops to be installed in South B.C. are:

- Crownsnest Pass, 4.16 km (2.9 miles)
- Flathead Ridge, 33.4 km (20.8 miles)
- Yahk area, 24.4 km (15.2 miles)
- Kingsgate-U.S. boundary, 26.7 km (16.6 miles)

Total authorized export through the pre-built western leg by Pan-Alberta Gas Ltd. on a firm and conditional basis between 1980-81 and 1987-88 amounts to 702.2 billion cu. ft. of gas.

U.S. Western Leg

From the border point at Kingsgate, B.C., gas will be moved southward to Stanfield, Oregon, by Pacific Gas Transmission through the addition of 160.5 miles of loops to its existing system. From Stanfield, the gas will be transported to southern California through the addition of some 565 km (351 miles) of loops to the Northwest Pipeline Co. system and by El Paso Natural Gas. PGT and Pacific Gas and Electric systems will eventually be paralleled for 911 miles over from Kingsgate to Antioch, Calif., near San Francisco.

PGT announced in mid-August that it had accepted the FERC certificate to build the 160.5 miles of 42-in. loops, to cost $186 million. The four major loops will be built in six sections. Section one is 40 miles in Idaho, with work to begin in December and completion by mid-May 1981. Bids are to be taken in October and contracts awarded in Novem-

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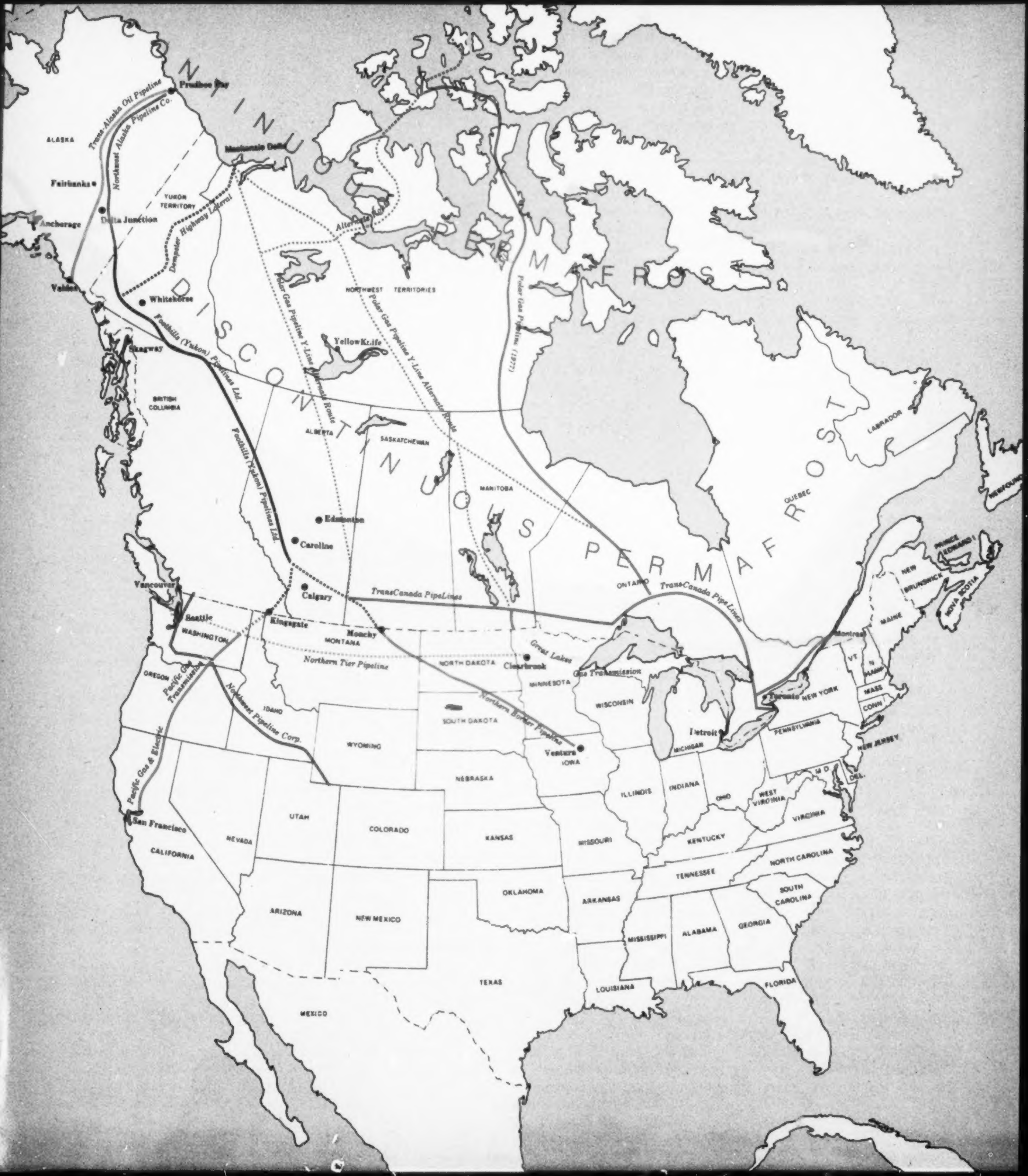
Pipeline & Gas Journal

ARCTIC ENERGY/PIPELINES

September 1980


CONTINUOUS PERMAFROST
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Prudhoe Bay
Trans-Alaska Oil Pipeline
Northwest Alaska Pipeline Co.
Fairbanks
Delta Junction
Anchorage
Valdez
Mackenzie Delta
YUKON TERRITORY
Dempster Highway Lateral
Whitehorse
Skagway
Foothills (Yukon) Pipelines Ltd.
BRITISH COLUMBIA
Alternate Route
NORTHWEST TERRITORIES
Polar Gas Pipeline Y-Line Alternate Route
Polar Gas Pipeline (1977)
YellowKnife
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
LABRADOR
NEWFOUNDLAND
PRINCE EDWARD I.
NEW BRUNSWICK
NOVA SCOTIA
Edmonton
Caroline
Calgary
Vancouver
Seattle
Kingsgate
Monchy
TransCanada PipeLines
Clearbrook
Great Lakes Gas Transmission
Northern Tier Pipeline
Northern Border Pipeline
Ventura
Toronto
Montreal
Detroit
Pacific Gas Transmission
Northwest Pipeline Corp.
Pacific Gas & Electric
San Francisco
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
WYOMING
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CALIFORNIA
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ber. Sections two and three in Washington and section four, from the Oregon-Washington border to Stanfield, Oregon, will be awarded in 1981.

Some $60 million in pipe orders has been awarded — Kaiser Steel will provide 61,000 tons of 42-in. pipe, and Bethlehem Steel will provide 20,000 tons. Deliveries are to begin in late November.

Eastern Leg in Canada

Pre-building of the eastern leg in Canada calls for 635 km (395 miles) of 42-in. pipe as part of a continuous, independent system stretching southeasterward from James River, Alberta, to the border point at Monchy, Saskatchewan. The line joins there with the U.S. eastern leg being built by the Northern Border Pipeline Company.

Construction of the eastern leg is planned to begin in the spring of 1981 with the line to go into operation in November with a capacity for the delivery of 900 Mmcf per day. Capacity for throughput between 1982-83 and 1985-86 will increase to a peak of 1.05 billion cu. feet daily.

The system in Alberta, to be built by Foothills Pipelines (Alta) Ltd., extends for 377 km (234 miles) from James River, Alberta to Empress, Saskatchewan. From Empress, the line runs 258 km (161 miles) to Monchy, Saskatchewan, and is being built by Foothills Pipelines (Sask) Ltd.

Four turbine-driven compressor units will be installed on the eastern leg in Canada, two at a station near Jenner, Alberta; a third near Piapot, Saskatchewan, and a fourth near Monchy.

Cost of pre-building the eastern leg in Canada is estimated at approximately $427 million.

Total authorized exports through the pre-build on a firm and conditional basis over the period from 1981-82 to 1987-88 amount to 1.6 trillion cubic feet.

U.S. Eastern Leg

Pre-building of the eastern leg in the United States will involve construction of 821 miles of 42-in. pipe by Northern Border Pipeline Co. from Monchy to Ventura, Iowa. The line will eventually be extended to Dwight, Illinois, providing transportation for Alaska gas over a distance of 1129 miles. Estimated cost of the pre-build is $1.2 billion.

Northern Border plans to begin construction in the spring of 1981, with work on all nine spreads to get underway almost simultaneously.

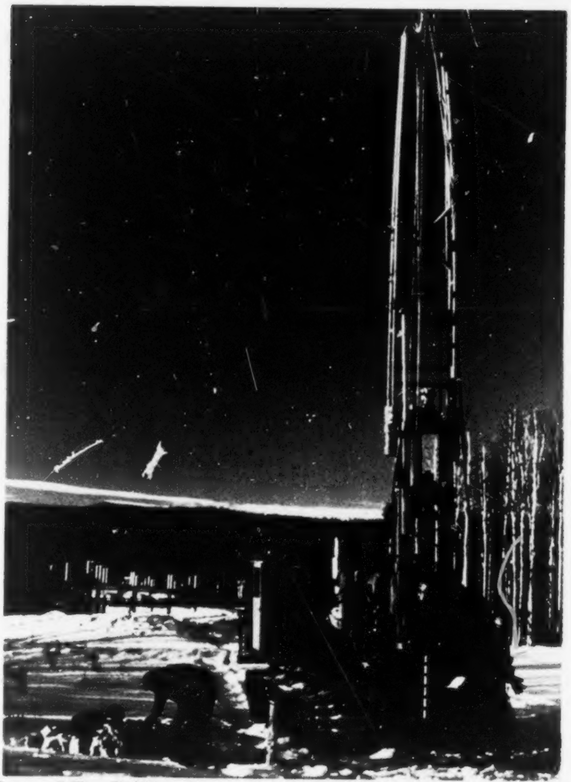
Pipe quotations from around the world are currently being reviewed and contracts for pipe are expected to be let in late 1980. Pipe will be double-jointed at storage sites along the route, with double-jointing to begin as soon as pipe deliveries begin.

Alaskan Pipeline Progressing

Two major filings were made July 1 by Alaskan Northwest Natural Gas Transportation Co., the consortium that will own the big gas pipeline between Prudhoe Bay and the Alaska-Yukon border. One was a supplement to a previous application to Department of Interior, requesting a single right-of-way grant for the pipeline through federal lands in Alaska. The line will traverse between 430 and 513 miles of federal land depending on the final resolution of pending land transfer cases.

The other major filing was to FERC seeking a final, unconditional Certificate of Public Convenience and Necessity authorizing construction of 743 miles of 48-in. and facilities, to cost $7.9 billion in 1980 dollars, exclusive of finance charges.

If the certificate is awarded by March 1, 1981, ANNGT—through Northwest Alaskan Pipeline Co., which will build and operate the line—plans to have construction complete in 1985, gas flowing from the conditioning plant by September 1, 1985, and gas flowing through the pipeline by November 1, 1985.



Crew of The Drilling Company, Anchorage, operates one of 17 drill rigs used in NWAPL's borehole drilling program, one of the largest field programs undertaken in preparation for building the Alaska Highway Gas Pipeline Project—soil samples collected for analysis will help determine frost heave potential along pipeline route.

Work on the pipeline itself would begin in February 1984. Civil construction work on the pipeline would begin in January 1983.

Involved in the pipeline plans are seven compressor stations, built on piled foundations, each having one 25,000-bhp gas turbine-driven compressor unit and two 10,000-bhp gas turbine-driven refrigeration units, with all equipment packaged and skid-mounted.

Two metering stations would be installed, involving five buildings on pile foundations, one at Prudhoe Bay and one at the Alaska-Yukon border.

Operation and maintenance facilities would be located at Fairbanks and at stations 2, 7, and 15; the latter would also serve as district headquarters locations.

Temporary facilities would include purchase of 16 pipeline camps and 8 station camps from Alyeska Pipeline Service Co. These would be renovated into 17 pipeline camps (14 to be used in place after renovation) with three to be relocated, plus seven camps to be used as station camps and relocated after renovation.

Of the 15 airfields required, 12 would have to be renovated. The Fort Wainwright offices in Fairbanks would also be completely renovated.

The communication system for the entire pipeline will be installed for and owned and operated by Northwest Alaska Pipeline.

The pipeline will involve 743 miles of 5LX-70 Arctic Grade pipe, 48-in. diameter, internally coated and externally coated with thin-film epoxy. Line will have 18,134 concrete weights and 24,320 ft of concrete coating. All double-jointing, coating, and insulation application will be done

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Over 1½-tons of documentation on the Alaska Natural Gas Transportation system represents filing by Northwest Alaskan Pipeline Co. to appropriate federal agencies for final certificate. Filing, made July 1, 1980, include 600 volumes of documentation plus 100 bound sets of drawings and represents a two-year design and estimating effort by NWAPL and project management contractor Fluor Engineers and Constructors, Inc.

in Fairbanks. Foreign sources would provide 75% of the pipe, U.S. sources 25%. Pipe is to be delivered internally coated.

Cost estimates are based on construction work at the work sites to be based on 7-day weeks at 10 hours per day, with staff work at 6 days per week and 10 hours per day.

Six construction sections are proposed, with one contractor per section.

Overall schedule for the project is:

3-1-81 Certificate granted.
4-15-81 Major engineered equipment ordered.
3-1-81 Unencumbered ROW grant given.
11-1-82 Majority of preconstruction activity completed.
1-1-83 Pipeline civil work to begin.
2-1-84 Mainline construction work to begin.
9-1-85 Mainline construction work complete.

Cost Estimate In 1980 Dollars

Compressor and metering stations	$ 693,073,000
Operation and maintenance facilities	53,428,000
Temp. facilities and services	886,707,000
Communications/supervisory systems	96,622,000
Pipeline	4,086,116,000
Project directorate	1,234,148,000
Normal contingency	846,006,000
Finance charge	894,300,000
TOTAL	$8,790,400,000

Selected Estimated Cost Items

Double-jointing of pipe	$ 29,700,000
156.3 miles of insulation	83,898,000
Thin film coating	60,206,000
Aerial crossings	25,262,000
Concrete weights, 1665 @ 13,500# each 17,318 @ 25,000# each	11,922,000
24,320 ft of concrete coating	2,666,000
Workpad insulation	5,141,000
Workpad construction	38,246,000
Access roads	3,248,000
Construction equipment	356,127,000
Construction equipment parts and tires	193,396,000
Pipeline labor costs	426,829,000
Pipeline indirect costs	745,977,000

Alaskan Gas Pipeline — Major Equipment Requirements

Equipment	Peak Requirements
Backhoes — Crawlers	124
Compactors	94
Compressors	293
Concrete Plants	19
Cranes	236
Crushing & Screening Plants	11
Dozers	479
Drills — Air	86
Forklifts	28
Generators & Light Plants (30KW and Larger)	331
Graders	108
Loaders	201
Personnel Transportation	2,414
Pile Driving & Drilling Sets	16
Pipelayers	325
Pipeline Specialty Equipment	138
Pumps (4 in. and Larger)	132
Scrapers	123
Support Vehicles	934
Trenching Machines	5
Trucks — Heavy Duty	895
Welding Machines	945
TOTAL	7,937

NOTE: Equipment requirements listed above reflect anticipated requirements.

Polar Gas Project

Polar Gas, a joint public/private project sponsored by TransCanada PipeLines (the project manager), Panarctic Oils Ltd., Tenneco Oil of Canada Ltd., Petro-Canada, and the Ontario Energy Corporation, plans to file a new application with the National Energy Board by the end of June 1981 for a combined pipeline system.

Application will be for a "Y"-line that will connect substantial gas reserves of both the Arctic Islands and the Mackenzie Delta to market. Established gas reserves in the two areas are now considered sufficient to support a pipeline.

Polar Gas began studies in 1972 on transporting large volumes of frontier gas, with early studies concentrated on connecting gas reserves of the High Arctic Islands and moving to market. Application for a pipeline was filed with NEB in late 1977, proposing a line from Melville Island to Longlac, Ontario, following a route west of Hudson Bay.

Advances in deep sea pipelaying technology prompted Polar Gas to consider a new route involving fewer marine crossings. New route would allow Polar Gas to transport Arctic Islands gas via M'Clure Strait and Dolphin and Union Strait to the Canadian mainland. Deep water crossings would be reduced from five to two.

In 1979, after six years of Arctic research, Polar Gas undertook additional field studies of the new routing via these two straits. No technical obstacles to marine pipelining were encountered at either strait.

Polar Gas is currently evaluating four "Y"-line options on the mainland, and additional detailed studies to assist in final route selection and support of an application for a combined pipeline system are being undertaken this year. Studies are to be completed by the end of 1980. **P&GJ**

First Half Reports:

Higher Prices from Decontrol Boost Earnings

by Greg Martin, Editor
Energy News and Energy Week

Higher prices for oil and gas — with or without greater production — were the most influential factor in increased earnings for 100 oil companies surveyed by ENERGY MANAGEMENT REPORT. Production units of large gas companies surveyed also boosted earnings, though utility earnings lagged for some.

Oil firms' earnings were up 56.4% in first half of 1980 over the same 1979 period. Profit increase exceeded revenue increase despite initial effects of the "windfall profits" tax (WPT). Many firms had record results in both second quarter and 6-month periods. (For free copy of *ENERGY WEEK's* report on windfall profits write Greg Martin, Box 1589, Dallas TX 75221.)

Higher prices buoyed earnings of smaller companies most, though WPT limited all increases.

In one example of how WPT affected net gain, Superior Oil said price decontrol contributed $31.5 million before tax to cash flow available for investment. WPT reduced funds by $15.9 million; after federal income tax, net benefit of decontrol was $8.4 million in first half. Benefit is expected to be lower in second half as WPT will be in effect for the whole period.

North American operations accounted for 84% of Gulf Oil's first half profits. Earnings from U.S. exploration/production more than doubled due to higher prices, despite a net production decline. Texaco's U.S. earnings increase was partly offset by lower gross liquids output and lower gas sales.

Main factor in earnings gains for Atlantic Richfield and Standard Ohio was Alaskan crude oil operations. ARGO noted that a recent ruling by Department of Energy, requiring higher entitlements payments for North Slope oil, will

FIRST HALF GAS COMPANY FINANCIAL REPORTS

	Three months ending June 30**						Twelve months ending June 30**						Profit Margin†	
	Revenues ($000)			Earnings* ($000)			Revenues ($000)			Earnings* ($000)				
Company	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979
Alabama Tennessee N.G.	20,124	15,230	+ 32.1	1,311	1,569	- 16.4	86,877	47,411	+ 83.2	5,154	3,974	+ 29.7	5.9	8.4
American Nat. Resources	590,117	516,621	+ 74.2	16,524	18,517	- 10.8	2,844,581	2,208,631	+ 28.8	116,548	92,167	+ 26.5	4.1	4.2
Coastal States	1,116,527	970,757	+ 15.0	28,590	25,702	+ 11.2	2,562,891[2]	1,957,828[2]	+ 30.9	54,981[2]	46,457[2]	+ 18.3	2.1	2.4
Columbia Gas	739,542	532,483	+ 38.9	30,629	27,230	+ 12.5	3,368,742	2,552,237	+ 32.0	151,341	132,043	+ 14.6	4.5	5.2
Commonwealth Nat. Res.	40,458	30,435	+ 32.9	1,041	1,055	- 1.3	189,326	129,986	+ 45.6	6,131	4,280	+ 43.2	3.2	3.3
Consolidated N.G.	464,856	392,273	+ 18.5	11,067	23,523	- 53.0	2,367,420	1,745,798	+ 35.6	117,918	110,089	+ 7.1	5.0	6.3
El Paso Companies	924,540	751,393	+ 23.0	6,131	40,723	- 84.9	1,952,928[2]	1,350,572[2]	+ 44.6	40,879[2]	72,012[2]	- 43.2	2.1	5.3
Enserch Corp.	617,744	488,731	+ 26.4	31,169	14,966	+108.3	1,312,431[2]	1,068,030[2]	+ 22.9	73,801[2]	45,827[2]	+ 61.0	5.6	4.3
Equitable Gas	198,940[2]	158,197[2]	+ 25.8	22,992[2]	18,609[2]	+ 23.6	324,761	260,691	+ 24.6	31,452	22,278	+ 41.2	9.7	8.5
Houston N.G.[1]	603,418	484,524	+ 24.5	56,031	37,839	+ 48.1	2,277,878	1,640,500	+ 38.9	188,562	127,986	+ 47.3	8.3	7.8
Internorth	603,871	523,083	+ 15.4	42,722	37,466	+ 14.0	2,832,839	2,123,270	+ 33.4	227,717	163,108	+ 39.6	8.0	7.7
Kansas Nebraska N.G.	75,651	71,641	+ 5.6	2,178	1,585	+ 37.4	345,482	303,761	+ 13.7	20,872	17,669	+ 18.1	6.0	5.8
Mountain Fuel Supply	224,889[2]	177,822[2]	+ 26.5	22,169[2]	15,700[2]	+ 41.2	381,851	307,475	+ 24.2	32,009	20,168	+ 58.7	8.4	6.6
National Fuel Gas	625,623[3]	511,462[3]	+ 22.3	30,169[3]	31,760[3]	- 5.0	730,871	580,114	+ 26.0	24,262	28,015	- 13.4	3.3	4.8
Northwest Energy	283,800	229,800	+ 23.5	10,700	7,600	+ 40.8	1,300,000	952,200	+ 36.5	51,300	31,500	+ 62.9	3.9	3.3
Oklahoma N.G.	205,506	154,767	+ 32.8	9,300	3,021	+207.9	821,790	665,374	+ 23.5	39,329	33,673	+ 16.8	4.8	5.1
Pacific Lighting	725,641	469,466	+ 54.6	22,855	21,723	+ 5.2	2,856,995	1,912,475	+ 49.4	91,406	90,240	+ 1.3	3.2	4.7
Panhandle Eastern	550,282	464,243	+ 18.5	37,842	32,513	+ 16.4	1,207,469	951,343	+ 26.9	98,720	85,056	+ 16.1	8.2	8.9
Peoples Energy	671,286	572,629	+ 17.2	25,700	24,100	+ 6.3	2,976,000	2,304,000	+ 29.2	141,300	131,800	+ 7.2	4.7	5.7
Pioneer Corp.	234,788	168,341	+ 39.5	22,390	16,473	+ 35.9	445,271[2]	326,155[2]	+ 36.5	45,820[2]	28,482[2]	+ 60.9	10.1	8.7
Southern Nat. Res.	399,859	327,990	+ 21.9	30,748	27,075	+ 13.6	1,735,454	1,258,236	+ 37.9	119,723	106,609	+ 12.3	6.9	8.5
Southern Union Co.	223,522	158,925	+ 40.6	8,562	5,388	+ 58.9	848,137	621,267	+ 36.5	40,933	24,552	+ 67.0	4.8	4.0
Texas Eastern Corp.	1,057,379	659,784	+ 60.3	55,569	38,851	+ 43.0	3,738,556	2,394,450	+ 56.1	203,601	150,378	+ 35.4	5.4	6.3
Texas Gas Trans.	511,124	380,787	+ 34.2	19,419	18,302	+ 6.1	1,096,457[2]	786,979[2]	+ 39.3	45,077[2]	34,508[2]	+ 30.6	4.1	4.4
TransCanada PipeLines	1,516,076[2]	1,199,708[2]	+ 26.4	47,322[2]	44,470[2]	+ 6.4								
Transco Companies	601,327	351,803	+ 71.0	27,228	16,405	+ 66.0	2,024,506	1,202,785	+ 68.0	92,398	58,591	+ 58.0	4.6	4.9
Union Gas Ltd.	146,294	131,770	+ 26.4	2,161	2,714	+ 25.6								
United Energy Res.	929,401	664,437	+ 39.9	37,096	23,214	+ 59.8	3,762,390	2,361,275	+ 59.3	140,869	89,075	+ 58.1	3.7	3.8
Westcoast Trans.							669,084[2]	504,808[2]	+ 32.5	25.351[2]	24,381[2]	+ 4.0	3.8	4.8
TOTALS	14,902,585	11,559,102	+ 28.9	659,615	578,093	+ 14.1	45,060,987	32,517,652	+ 38.6	2,227,454	1,774,918	+ 25.5	4.9	5.5

**Excluding non-recurring items. *Earnings available to common stock. †Ratio = Earnings ÷ Revenues. [1]Ends April 30. [2]Six months. [3]Nine months.

greatly raise refining costs for Alaskan producers, though it will reduce costs for other refiners.

"Upward price movements" were cited by Exxon for U.S. oil/gas operations. Improved worldwide earnings featured "better margins in foreign downstream operations." Conoco enjoyed "improved refined products margins overseas, higher crude oil margins in U.S. and increased crude oil production in North Sea."

Higher production earnings, both domestically and overseas, plus higher investment tax credits, boosted results of Union Oil. Phillips Petroleum credited greater output and higher prices worldwide for its improved first half. Marathon Oil said "all improvement in the 1980 second quarter resulted from activities in U.S." where net income more than doubled.

Standard California's domestic earnings benefited from higher prices and greater sales; lower margin on refined product sales abroad was more than offset by higher oil/gas prices and production. Socal said it paid almost $1.2 billion in taxes, more than double its after-tax earnings.

Cities Service said most business areas were ahead of 1979 levels in profitability though gas transmission volumes were lower. International energy results were "bolstered by profitable performance of the Syncrude tar sand operation in Canada."

Integrated oil operations showed greatest gain for Tenneco; shipbuilding earnings were stronger and gas pipeline division showed improvement.

Price increases were main reason for Ashland Oil's earnings rise. Amerada Hess had sharply higher production income, though refined product sales were down.

Oil/gas sales more than tripled for Seneca Oil due to higher prices and a significant increase in output from new wells coming on stream.

All segments of Natomas — oil production and marketing, coal, geothermal — set 6-month earnings records. Income from international petroleum operations more than doubled.

Record 6-month results for American Quasar were due to higher prices and a 27% increase in natural gas output from new discoveries and development of existing properties. Oil/gas sales rose 59% for Dyco Petroleum over first half of 1979 despite summer curtailment of gas sales.

North American operations brought higher income for Belco Petroleum, offsetting a decline in earnings from Peru.

Higher prices boosted revenues of Patrick Petroleum but net income fell because of high interest rates and lower sales by the firm's joint venture interests. Consolidated Oil & Gas blamed earnings decline on its equity share of losses of R.L. Burns Corp.

Refining/marketing operations were a mixed bag. Total Petroleum attributed sharp earnings gain to these operations. Investments in refinery upgrading led to a higher yield of light products.

Tosco's refining margins were strong throughout first half despite "unusually high gasoline inventories east of the Rockies."

Refining/marketing contributed greatest share of improved

FIRST HALF OIL COMPANY FINANCIAL REPORTS

		Three months ending June 30**						Six months ending June 30**						Profit Margin†	
		Revenues ($000)			Earnings* ($000)			Revenues ($000)			Earnings* ($000)				
		1980	1979	% Chg.	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979	% Chg.	1980	1979
1.	Adams R&E	57,394	43,223	+ 32.8	(1,839)	585	-	119,705	73,550	+ 62.8	(1,957)	741	-	none	1.0
2.	Adobe Oil	38,690	20,252	+ 91.0	4,956	3,050	+ 62.5	74,775	37,795	+ 97.8	9,337	5,020	+ 86.0	12.5	13.3
3.	Amerada Hess	1,660,348	1,578,472	+ 5.2	140,395	130,194	+ 7.8	3,985,746	3,117,083	+ 27.9	320,773	259,888	+ 23.4	8.0	8.3
4.	American Petrofina	494,147	356,214	+ 38.7	25,123	16,237	+ 54.7	1,017,521	701,861	+ 45.0	56,533	27,597	+104.9	5.6	3.9
5.	American Quasar	10,353	6,234	+ 66.1	999	(144)	-	19,428	13,178	+ 47.4	3,004	481	+524.5	15.5	3.7
6.	Argonaut Energy	693	624	+ 11.9	10	(27)								1.4	none
7.	Argo Petroleum	2,983	2,061	+ 44.7	363	130	+179.2	6,212	3,962	+ 56.8	837	135	+520.0	13.5	3.4
8.	Ashland Oil	2,158,666	2,337,120	- 7.6	46,542	395,432	- 88.2	6,284,821[3]	5,350,986[3]	+ 17.5	169,869[3]	473,362[3]	- 64.1	2.7	8.8
9.	Asamera	80,068	54,726	+ 46.3	2,919	3,399	- 14.1							3.6	6.2
10.	Atlantic Richfield	5,642,159	3,731,485	+ 51.2	434,806	260,362	+ 67.0	11,075,926	7,248,403	+ 52.8	806,925	502,573	+ 60.6	7.3	6.9
11.	Beard Oil	4,948	2,891	+ 71.2	1,207	367	+228.6	10,657	5,914	+105.1	2,409	375	+542.1	22.6	7.2
12.	Belco Petroleum	199,637	129,983	+ 53.6	18,761	16,801	+ 11.7	411,180	255,250	+ 61.1	37,004	31,206	+ 18.6	9.0	12.2
13.	Brock Exploration	1,057	988	+ 6.9	55	237	- 23.2							5.2	24.0
14.	C&K Petroleum	10,099	6,616	+ 52.6	1,341	326	+311.3	18,762	13,137	+ 42.8	2,462	700	+251.7	13.1	5.3
15.	Cities Service	1,814,300	1,425,300	+ 27.3	107,000	76,700	+ 39.5	3,986,300	2,870,900	+ 38.9	277,100	155,200	+ 78.5	7.0	5.4
16.	Clark O&R	431,167	276,736	+ 55.8	11,246	9,442	+ 19.1	833,441	534,934	+ 55.8	25,346	15,529	+ 63.2	3.0	2.9
17.	Commonwealth OR	298,000	321,000	- 1.7	(13,900)	37,700	-	604,000	557,000	+ 8.4	(23,200)	48,100	-	none	8.6
18.	Consolidated O&G	8,049	7,491	+ 7.4	(384)	1,566	-	16,008	14,418	+ 11.0	(290)	(873)	+ 66.8	none	none
19.	Conoco Inc.	4,700,000	3,000,000	+ 63.3	249,600	215,800	+ 15.7	9,000,000	5,800,000	+ 55.2	578,200	377,600	+ 53.1	6.4	6.5
20.	Crystal Oil	60,491	36,721	+ 64.7	1,758	2,474	- 28.9	118,812	65,214	+ 82.2	4,645	3,565	+ 30.3	3.9	5.5
21.	Damson Oil	6,274	4,875	+ 28.7	1,110	695	+ 59.7	20,072[3]	13,044[3]	+ 53.9	2,160[3]	542[3]	+298.5	10.8	4.2
22.	Delhi Int'l Oil	6,886	4,006	+ 71.9	1,440	802	+ 79.5	12,482	7,250	+ 72.2	2,552	1,380	+ 84.9	20.4	19.0
23.	Diamond Shamrock	769,130	574,225	+ 33.9	56,346	52,965	+ 6.4	1,524,461	1,079,230	+ 41.3	112,601	82,494	+ 36.5	7.4	7.6
24.	Dorchester Gas[2]	135,493	95,643	+ 41.7	8,882	6,941	+ 28.0	453,918[3]	242,868[3]	+ 86.9	25,215[3]	15,138[3]	+ 66.6	5.6	6.2
25.	Dyco Petroleum	6,845	5,033	+ 36.0	1,919	991	+ 93.6	12,963	8,606	+ 50.6	3,530	1,783	+ 98.0	27.2	20.7
26.	Earth Resources[2]	230,968	91,454	+152.5	8,024	4,610	+ 74.1	373,797	178,658	+109.2	14,597	1,697	+118.0	4.0	3.7
27.	Energy Reserves Group	37,165	21,758	+ 70.8	5,131	2,623	+ 95.6	73,209	40,595	+ 80.3	13,672	(466)	-	18.7	none
28.	Equity Oil	3,666	2,783	+ 31.7	948	623	+ 52.2	6,970	5,450	+ 27.9	1,789	1,167	+ 53.3	25.7	21.4
29.	Exeter Oil	889	498	+ 78.6	332	137	+141.7	1,753	878	+ 99.7	555	141	+292.1	31.7	16.1
30.	Exxon	26,223,000	18,599,000	+ 41.0	1,030,000	830,000	+24.1	53,877,000	37,427,000	+ 44.0	2,955,000	1,785,000	+ 65.5	5.5	4.8
31.	Felmont	14,940	10,062	+ 48.5	4,201	1,820	+130.9	26,888	19,187	+ 40.1	7,950	4,272	+ 86.1	29.6	22.3
32.	Forest	21,863	14,240	+ 53.5	538	448	+ 20.1	43,327	32,014	+ 35.3	2,661	2,535	+ 5.0	6.0	8.0
33.	Galaxy Oil[2]	2,793	1,545	+ 80.8	37	(287)	-	9,387[4]	6,037[4]	+ 55.5	302[4]	(312)[4]	-	3.2	none
34.	Getty Oil	2,643,318	1,149,225	+130.0	242,887	139,229	+ 74.5	4,912,017	2,244,916	+118.8	468,435	247,156	+ 89.5	9.5	11.0
35.	Great Basins[1]	6,433	4,781	+ 34.6	(897)	189	-	16,862[3]	14,219[3]	+ 18.6	(2,918)[3]	1,434[3]	-	none	10.1
36.	§Gulf Oil Corp.	6,800,000	6,108,000	+ 11.3	370,000	291,000	+ 27.1	14,556,000	11,674,000	+ 24.7	759,000	540,000	+ 40.6	5.2	4.6
37.	Hadson Petroleum	3,011	1,375	+119.0	897	228	+293.3	5,397	2,538	+112.6	1,572	474	+231.7	29.1	18.7
38.	Hamilton Bros. Petr.	28,610	29,708	- 3.7	6,902	3,187	+116.6	54,076	58,875	- 8.2	13,919	4,345	+220.3	25.7	7.4
39.	Helmerich & Payne	52,060	38,593	+ 34.9	12,054	8,564	+ 40.8	152,401[3]	111,520[3]	+ 36.7	34,436[3]	24,243[3]	+ 42.0	22.6	21.7
40.	Houston O&M	101,286	76,354	+ 32.7	14,626	13,613	+ 7.4	198,568	157,996	+ 25.7	29,216	26,670	+ 9.5	14.7	16.9
41.	Howell Corp.	69,746	68,172	+ 2.3	2,166	7,171	- 69.8	139,032	127,004	+ 9.5	10,322	9,894	+ 4.3	7.4	7.8
42.	Inexco Oil	35,977	23,536	+ 52.9	5,602	3,859	+ 45.2	67,697	45,746	+ 47.9	11,349	7,598	+ 49.4	16.8	16.6
43.	Juniper Petroleum	5,786	3,861	- 3.7	556	316	+ 75.9	12,639	6,691	+ 88.9	2,047	468	+337.4	16.2	7.0
44.	KRM Petroleum	1,194	602	+ 98.3	185	39	+374.4	2,402	1,087	+121.0	575	29	+1882.8	23.9	2.7
45.	Kerr-McGee Corp.	854,246	646,308	+ 32.2	49,577	43,587	+ 13.7	1,634,640	1,248,201	+ 31.0	96,719	77,029	+ 25.6	5.9	6.2
46.	Lear Petroleum	19,624	16,633	+ 18.0	1,714	941	+ 82.1	65,547[3]	55,377[3]	+ 18.4	5,340[3]	3,240[3]	+ 64.8	8.1	5.9
47.	Louisiana L&E	258,436	207,128	+ 24.8	42,832	53,270	- 19.6	523,390	367,605	+ 42.4	94,425	87,040	+ 8.5	18.0	23.7
48.	MGF Oil	19,164	9,806	+ 95.4	1,452	90	+1513.3	34,139	21,860	+ 56.2	2,707	475	+470.0	7.9	2.2
49.	Mapco Inc.	197,707	189,108	+ 4.6	22,455	17,967	+ 25.0	437,449	341,846	+ 28.0	43,043	31,323	+ 37.4	9.8	9.2
50.	§Marathon Oil	2,039,893	1,591,911	+ 28.1	108,325	84,831	+ 27.7	4,305,261	3,065,600	+ 40.4	247,396	189,305	+ 30.7	5.7	6.2
51.	Marion Corp.	137,253	97,112	+ 41.3	4,956	6,248	- 20.7	237,105	135,897	+ 74.5	8,953	8,118	+ 10.3	3.8	6.0
52.	May Petroleum	5,757	3,991	+ 44.2	1,224	570	+114.7	11,083	6,996	+ 58.4	2,577	94[illegible]	+172.1	23.3	13.5
53.	Maynard Oil[2]	7,452	4,262	+ 74.8	1,217	804	+ 51.4	24,544[4]	16,495[4]	+ 48.8	3,751[4]	1,985[4]	+136.7	15.3	9.6
54.	Mesa Petroleum	89,527	57,288	+ 56.3	23,405	11,314	+106.9	190,105	112,686	+ 68.7	42,991	25,671	+ 67.5	22.6	22.8
55.	Mitchell Energy[1]	142,270	85,489	+ 66.4	23,470	9,474	+147.7								
56.	§Mobil Corp.	15,396,680	10,707,963	+ 43.8	687,856	418,783	+ 64.3	30,675,163	21,110,210	+ 45.3	1,533,460	867,345	+ 76.8	5.0	4.1
57.	Murphy Oil	454,838	363,203	+ 25.3	35,633	21,891	+ 62.8	1,024,083	726,786	+ 40.9	64,023	36,935	+ 73.3	6.3	5.1
58.	Natomas	364,607	247,579	+ 47.3	57,399	25,651	+123.8	683,683	467,436	+ 46.3	105,414	43,926	+140.0	15.4	9.4
59.	Noble Affiliates	67,265	50,195	+ 34.0	12,090	6,650	+ 81.8	134,849	97,160	+ 38.8	25,549	12,879	+ 98.4	18.9	13.3
60.	Norris Oil	307	85	+261.2	10	(76)	+113.2	551	179	+207.8	37	(121)	+130.6	6.7	none
61.	Occidental Petr.	2,998,563	2,237,594	+ 34.0	153,193	97,314	+ 57.4	6,345,169	4,080,188	+ 55.5	422,899	171,023	+147.3	6.1	4.2
62.	Oxoco	2,797	2,762	+ 1.3	311	64	+385.9	5,434	4,561	+ 19.1	562	111	+406.3	10.3	2.4
63.	Pacific Resources	179,983	108,988	+ 65.1	4,871	1,851	+163.2	386,943	223,575	+ 73.1	13,901	5,163	+169.2	3.6	2.3
64.	Patrick Petroleum[1]	13,583	8,987	+ 51.1	1,049	1,461	- 28.2	43,029[4]	35,931[4]	+ 19.8	1,035[4]	3,107[4]	- 66.7	2.4	8.6
65.	Pauley Petroleum[2]	43,144	31,868	+ 35.4	(2,149)	2,901		126,601[3]	78,925[3]	+ 60.4	1,903[3]	(222)[3]			
66.	Peninsula Resources	3,511	2,460	+ 42.7	260	(31)	+938.7	6,851	4,347	+ 57.6	405	88	+360.2	5.9	2.0
67.	Pennzoil Co.	630,996	493,242	+ 27.9	77,648	58,023	+ 33.8	1,243,901	926,663	+ 34.2	161,284	104,196	+ 54.8	13.0	11.2
68.	Phillips Petroleum	3,230,179	2,216,922	+ 45.7	214,849	214,602	+ 0.1	6,614,341	4,203,946	+ 57.3	499,263	391,603	+ 27.5	7.5	9.3
69.	Premier Resources	1,247	1,165		(9)	89		3,777	3,126		1,052	131			
70.	Quaker State	200,891	180,936	+ 11.0	7,496	13,195	- 43.2	395,751	338,091	+ 17.1	14,375	21,107	- 31.9	3.6	6.2
71.	Seneca Oil	2,077	632	+228.6	322	30	+972.0	4,807[3]	1,620[3]	+197.0	661[3]	46[3]	+1333.0	13.8	2.9
72.	Shell Oil	4,895,000	3,403,000	+ 43.8	407,000	277,000	+ 46.9	9,693,000	6,479,000	+ 49.6	780,000	501,000	+ 55.7	8.0	7.7
73.	Southland Royalty	92,336	61,469	+ 50.0	15,386	11,802	+ 30.0	182,971	112,829	+ 62.0	34,186	21,907	+ 56.0	18.7	19.4
74.	Standard Calif.	10,649,000	6,975,000	+ 52.7	535,000	383,000	+ 52.8	21,096,000	13,933,000	+ 51.4	1,162,000	726,000	+ 60.1	5.5	5.2
75.	Standard Indiana	7,300,000	4,600,000	+ 58.7	488,200	350,200	+ 39.4	13,700,000	9,000,000	+ 52.2	1,064,200	700,200	+ 52.0	7.8	7.8
76.	Standard Ohio	2,840,600	1,818,000	+ 56.2	451,300	201,400	+124.1	5,499,300	3,468,500	+ 58.5	902,000	368,908	+144.5	16.4	10.6
77.	Statex Petroleum[1]	1,596	917	+ 74.0	317	150	+111.3	2,839	1,839	+ 54.4	503	277	+ 81.6	17.7	15.1
78.	Sun Co.	3,000,000	2,500,000	+ 20.0	247,000	166,800	+ 48.0	6,100,000	4,900,000	+ 25.0	498,300	295,100	+ 69.9	8.2	6.0
79.	Sundance Oil	3,631	3,044		(3,753)	(330)		7,915	6,988		(4,836)	(1,746)			
80.	Superior Oil	350,618	258,901	+ 35.4	68,635	48,590	+ 41.3	680,905	478,129	+ 42.4	159,201	88,917	+ 79.0	23.4	18.6
81.	Supron Energy	16,191	10,950	+ 47.8	4,625	3,127	+ 47.9	31,247	22,089	+ 41.5	9,325	6,273	+ 48.7	29.8	28.4
82.	Tenneco	3,201,000	2,704,000	+ 18.4	186,000	153,000	+ 21.6	6,517,000	5,151,000	+ 26.5	364,000	276,000	+ 31.9	5.6	5.4
83.	Tesoro	780,784	878,194	- 11.1	23,068	14,752	+ 56.4	2,641,724[3]	1,704,090[3]	+ 55.0	99,066[3]	34,528[3]	+186.9	3.8	2.0
84.	Texaco Inc.	12,539,000	8,503,000	+ 47.5	502,937	337,458	+ 49.0	25,788,000	16,861,000	+ 52.9	1,103,516	641,391	+ 72.1	4.3	3.8
85.	Texas American	33,079	26,799	+ 23.4	521	1,360	- 61.6	66,216	49,326	+ 34.2	1,207	1,577	- 23.5	1.8	3.2
86.	Texas Oil & Gas[2]	303,856	252,140	+ 21.0	37,250	25,867	+ 44.0	866,597[3]	643,072[3]	+ 35.0	101,292[3]	69,104[3]	+ 47.0	11.7	10.7
87.	Tipperary Corp.	20,852	15,520	+ 34.4	1,681	1,319	+ 27.4	58,957[3]	39,314[3]	+ 50.0	4,895[3]	1,307[3]	+274.5	13.4	3.3
88.	Tomlinson Oil[2]	16,091	10,051	+ 60.1	274	1,420	- 80.7	44,182[3]	22,651[3]	+ 95.1	2,504[3]	2,040[3]	+ 22.7	5.7	9.0
89.	Tosco Corp.	598,264	442,643	+ 35.2	18,583	19,668	- 5.5	1,132,426	798,910	+ 41.7	41,212	31,426	+ 31.1	3.6	3.9
90.	Total Petroleum N.A.	326,531	205,392	+ 59.0	18,291	4,591	+298.4	641,120	379,442	+ 69.0	26,362	9,321	+182.8	4.1	2.5
91.	Transcontinental Oil	20,507	15,242	+ 34.5	1,549	(1,594)	-	38,497	30,022	+ 28.2	1,425	(2,502)	-	3.7	none
92.	Union California	2,648,001	1,764,146	+ 50.1	194,817	128,242	+ 51.9	4,930,334	3,426,479	+ 43.9	347,739	242,346	+ 43.5	7.1	7.1
93.	United Refining	166,350	111,437	+ 49.3	2,147	3,478	- 38.2	315,634	213,606	+ 47.7	4,394	6,704	- 34.4	1.4	3.1
94.	Universal Resources[1]	9,626	5,774	+ 66.7	1,783	617	+189.0	18,913	11,418	+ 65.6	3,155	1,230	+156.5	16.7	10.8
95.	Wainoco Oil	8,275	4,962	+ 66.8	670	1,032	- 35.1	17,821	10,340	+ 72.4	3,600	2,522	+ 42.7	20.2	24.4
96.	Wichita Industries	2,618	1,624	+ 61.2	602	144	+318.1	4,814	2,622	+ 83.6	956	164	+482.9	19.9	6.3
97.	Williams Companies	574,511	525,597	+ 9.3	52,278	26,720	+ 95.7	1,053,848	947,730	+ 11.2	87,401	34,159	+155.9	8.3	3.6
98.	Wilshire Oil of TX	14,095	12,686	+ 11.1	672	532	+ 26.3	29,095	25,258	+ 15.2	1,425	1,063	+ 34.1	4.9	4.2
99.	Wiser Oil	14,950	8,263	+ 80.9	3,315	2,159	+ 53.5	30,061	16,863	+ 78.3	8,351	4,792	+ 74.3	27.8	28.4
100.	Woods Petroleum	12,880	10,319	+ 24.8	3,311	2,994	+ 10.6	36,023	20,279	+ 77.6	6,376	5,737	+ 11.1	17.7	91.6
	TOTAL	132,682,826	95,160,153	+ 39.4	7,599,759	5,797,386	+ 31.1	270,523,600	186,600,583	+ 45.0	16,948,141	10,810,847	+ 56.8	6.3	5.8

**Excluding non-recurring items. *Earnings available to common stock. §Revenues include excise taxes. †Earnings* divided by Revenues. [1] Ends April 30. [2] Ends May 31. [3] Nine months. [4] Twelve months. ()Loss.

profits for American Petrofina. Production income also was significantly higher but limited by WPT. Higher retail gasoline prices offset lower fuel oil prices and higher crude costs for Clark Oil & Refining.

Pennzoil said the U.S. entitlements program puts refiners of Appalachian crude at a "severe competitive disadvantage," causing a decline in marketing income. Reason for Pennzoil's earnings gain was higher gas sales and higher prices on all production.

Louisiana Land & Exploration blamed second quarter earnings decline on lower refinery profit margin, caused by higher crude costs. United Refining could not recover rising crude costs and interest expense through higher product prices because of competitive conditions. Crown Central's sales were hurt by conservation of gasoline and distillate fuels.

Healthy coal operations and higher oil/gas prices brought record earnings for MAPCO. Greater than expected losses of coal division were main reason for Adams Resources & Energy's net loss. Coal operations also slumped for Ashland.

Reduced gas sales volumes, mainly to industrial customers because of the current recession, bit into earnings of some integrated gas companies. Still, earnings of the 29 firms surveyed rose 25.5% in the year ended June 30, 1980. Oil/gas production and contract drilling operations were increasingly profitable.

Earnings gains for InterNorth, Inc. were led by Northern Liquid Fuels division. Lower gas sales to large industrial users and warmer weather caused a 32% drop in earnings of Northern Natural Gas. Texas Eastern attributed higher income mainly to higher prices for North Sea oil and greater volume of domestic product sales.

Record second quarter for Texas Gas Transmission was due primarily to the company's inland waterways operations as the gas transmission unit had lower earnings. Southern Union's income gains were due to gas processing operations, which benefited from sharply higher prices for natural gas liquids (decontrolled).

Peoples Energy Corp.'s gas pipeline unit sold less gas to major distribution company customers. This, along with "mounting pressure" on take-or-pay gas purchase obligations, is expected to offset anticipated earnings gains in fourth quarter.

Enserch Corp. had higher production income due to higher prices and greater sales. Utility earnings benefited from off-system gas sales to other pipeline companies. Higher income for United Energy Resources reflected more gas sales by pipeline units and greater production by Cotton Petroleum subsidiary.

Oklahoma Natural Gas plans to spend about twice as much on nonutility as on utility operations over next three years as production, gas processing and contract drilling are more profitable. Record second quarter for Pioneer Corp. was credited to production gains, higher NGL prices and high demand for contract drilling services.

El Paso's second quarter earnings were hurt by cutoff of liquefied natural gas deliveries from Algeria. Cutoff is expected to cause "substantial adverse impact" until LNG is back on stream.

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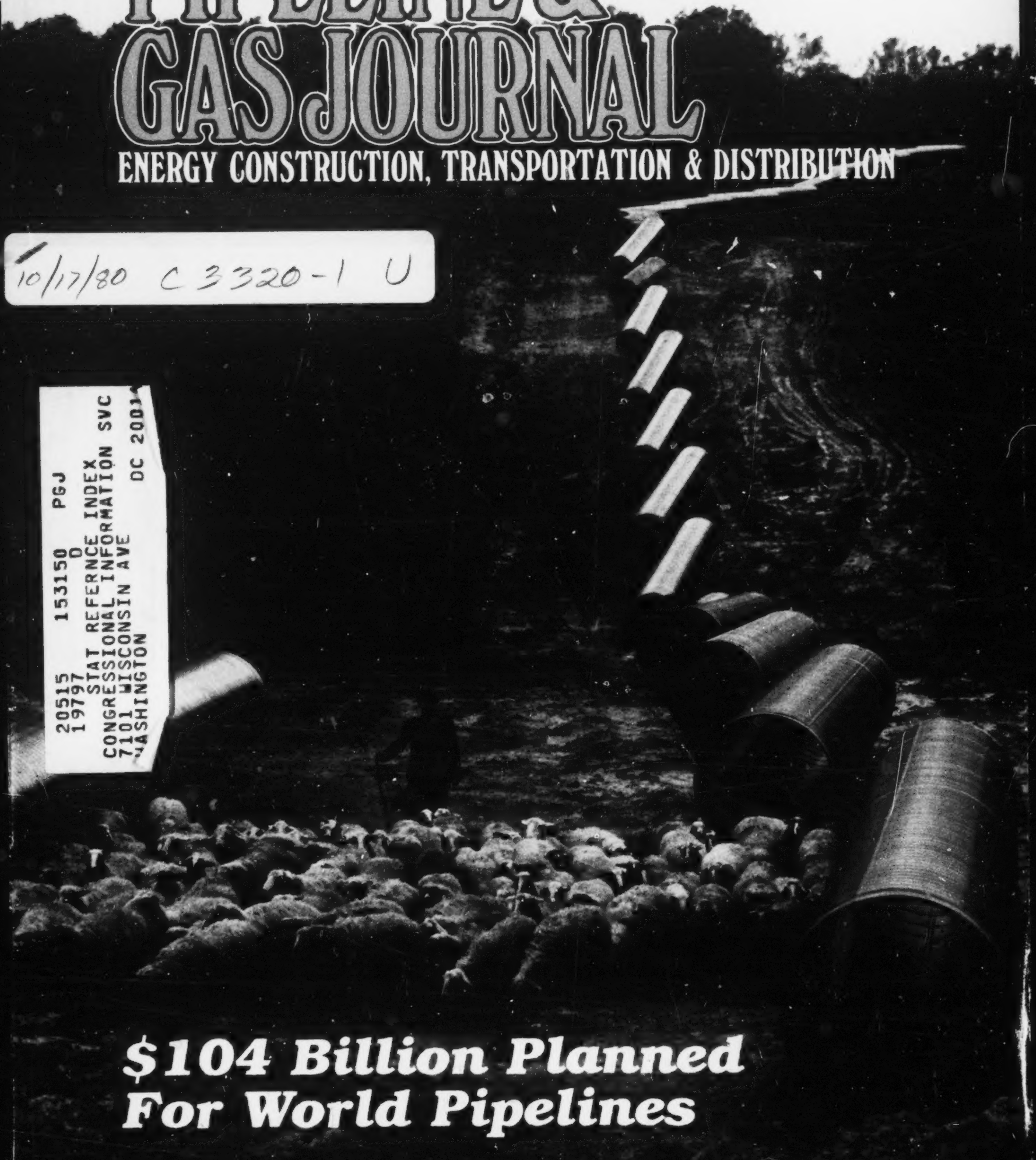

$104 Billion Planned For World Pipelines

PIPELINE & GAS JOURNAL
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THE COVER
Italian farmer keeps an eye on his flock as a major segment of the 48-in. Trans-Mediterranean Gas Pipeline takes shape in his pasture in Calabria section of southern Italy.

—photo courtesy Saipem s.P.a.

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World energy demand has created a need for more pipelines of all types; latest P&GJ survey indicates over 85,000 miles planned or underway — all of it outside the U.S. — at a total cost of over $104 billion.

Petroline Welded Out 22
Construction of the 787-mile, 48-in. crude oil pipeline running from east to west across Saudi Arabia has been completed; work on pumping stations and the Yanbu Terminal are progressing on schedule.

Aramco Line Nearing Completion 30
Big 747-mile 28/30-in. gas liquids pipeline, laid parallel to the 48-in. Petroline, has been welded out by contractor; east-to-west line also terminates at Yanbu facilities.

Trans-Med Gas Line Set For 1982 38
Castoro Sei, the huge semi-submersible pipelaying vessel, has completed two of three 20-in. lines between Sicily and Tunisia, may complete third line by Christmas; landlines in Algeria, Tunisia, Sicily, and southern Italy also being flanged-up.

French Gas Line Completed 46
Nozay-Neuvelle section of new gas pipeline between Nozay and Beynes storage field has been completed for Gaz de France.

Oil and Gas Lines Laid In Same Ditch . . . 54
New 445 km, 18-in. crude oil pipeline extends transportation system in Oman southward to Marmul and new oil fields.

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A pioneering 3.85 km insulated, SECT-heated submarine pipeline near Ancona, Italy, connects Falconara Refinery with an unloading platform in the Adriatic Sea.

Enagas Operating First Gas Pipeline 69
New 730 km gas transmission pipeline is first — and major — segment of a 1020 km pipeline system that will supply gas to most of the industrialized areas of Spain.

Argentina Building 1730 km System 77
Giant $1.5 billion, 1730 km Cental-West gas pipeline project is getting underway in Argentina; pipe shipped in huge barge-loads from Netherlands; Cogasco consortium will operate line for 15 years after constructing it.

What's New In Construction Equipment 82
Showcase of recent innovations in construction equipment for pipeline contractors.

Denmark Plans 13,230 Km System 88
First section of ambitious Danish gas program will get underway in 1981 with building of a 24-in. major feeder.

Major part of the Trans-Mediterranean Gas Pipeline — the 230-mile 48-in. section across Tunisia from the Algerian border to Cap Bon that crosses desert areas — has been completed ahead of schedule.

High Global Energy Demand Stimulating World Pipeline Activity

by Dean Hale, *Editor*

World energy demand is producing a record demand for new oil, natural gas, petroleum products, and slurry pipelines, with nearly 85,000 miles planned or underway — at a cost of over $104 billion — around the world (outside of the United States), reveals PIPELINE & GAS JOURNAL's survey of world pipeline activity. The total figure of 84,559 miles includes 16,961 miles of planned or underway pipelines in the U.S.S.R., the Eastern Bloc countries, and the Peoples Republic of China. Excluded are 5500 miles of pipeline in Iran.

The world pipeline scene continues to change and 85,000-mile total reflects an astonishing record of completions on major pipeline projects around the world, including the 787-mile, 48-in. Petroline across Saudi Arabia and its parallel 747-mile natural gas liquids line for Aramco; the completion of two of Trans-Mediterranean Pipeline's 100-mile, 20-in. undersea crossings between Tunisia and Sicily as well as the major land segments across Algeria, Tunisia, Sicily and the southern tip of Italy; completion of the Middle European Gas Line (MEGAL) system in Austria, West Germany, and France; numerous oil, gas, and product lines in Mexico; and many major projects in the Middle East, North Africa, and Europe.

Even so, there is an exciting ledger of new projects on the drawing boards and under construction around the world.

P&GJ's survey indicates that natural gas pipelines account for 64.4% of the total pipelines now planned or underway — 54,465 miles of gas pipelines with 9456 miles under construction. Crude oil pipelines account for another 22.5%, with 19,035 total miles and 5293 being built. Products pipelines represent 10.6%, with 8931 total miles and 1309 miles underway and slurry pipelines represent 2.5%, with a total of 2128 miles planned.

INTERNATIONAL PIPELINE CONSTRUCTION — BY TYPE OF LINE

(As of September 1980)

	Miles		
Type of Line	Total	U/C	Planned
Gas	54,465	9,456	45,009
Crude	19,035	5,293	13,742
Products	8,931	1,309	7,622
Slurry	2,128	—	2,128
TOTALS	84,559	16,058	68,501

INTERNATIONAL PIPELINE CONSTRUCTION — BY COUNTRY

(Underway, Planned, and Proposed — September 1979) in Miles

	Miles of Gas Pipelines		Miles of Crude Oil Pipelines		Miles of Product Pipelines		Miles of Slurry Pipelines		Total Miles	
	Total	Underway	Total	Underway	Total	Underway	Total	Underway	Total	Underway
Abu Dhabi	368	230	860	860	—	—	—	—	1088	950
Algeria	2721	872	390	390	698	698	—	—	3809	1960
Argentina	2501	1084	300	—	12	—	88	—	2901	1084
Australia	1650	110	3	3	403	101	15	—	2071	214
Bangladesh	122	—	—	—	—	—	—	—	122	—
Belgium	109	—	—	—	—	—	—	—	109	—
Bolivia	2012	—	—	—	536	—	—	—	2548	—
Brazil	2741	—	1005	442	492	199	9	—	4157	641
Canada	9807	720	3738	146	1098	—	—	—	14643	866
Chile	564	—	20	—	—	—	45	—	629	—
China	1200	—	2200	—	—	—	—	—	3400	—
Colombia	500	—	370	250	165	40	—	—	1035	290
Congo	14	—	—	—	—	—	—	—	14	—
Czechoslovakia	535	535	—	—	—	—	—	—	535	535
Denmark	8220	—	—	—	—	—	—	—	8220	—
Dubai	—	—	17	—	—	—	—	—	17	—
Ecuador	478	162	6	—	—	—	—	—	484	162
Egypt	168	—	200	200	—	—	—	—	368	200
France	2330	1200	350	—	169	—	—	—	2849	1200
Greece	70	—	50	—	—	—	—	—	120	—
Honduras	—	—	160	—	—	—	—	—	160	—
Hungary	—	—	188	—	112	—	—	—	300	—
India	—	—	120	—	300	—	171	—	591	—
Indonesia	—	—	62	—	—	—	—	—	62	—
Iran*	*	*	*	*	*	*	—	—	*	*
Iraq	800	350	1322	—	684	—	—	—	2806	350
Italy	863	253	—	—	—	—	—	—	863	253
Japan	230	—	—	—	—	—	—	—	230	—
Kuwait	—	—	400	400	23	—	—	—	423	400
Libya	—	—	511	280	—	—	—	—	511	280
Malaysia	80	—	—	—	—	—	—	—	80	—
Mexico	2710	1560	750	572	427	51	—	—	3889	2133
Netherlands	6	—	—	—	100	—	—	—	106	—
New Zealand	100	—	—	—	93	—	—	—	193	—
Nigeria	—	—	75	—	—	—	—	—	75	—
Norway	600	—	—	—	—	—	—	—	600	—
Oman	140	—	510	—	—	—	—	—	650	—
Pakistan	1025	—	1625	1095	—	—	—	—	2650	1095
Panama	—	—	36	—	—	—	—	—	36	—
Poland	—	—	—	—	—	—	350	—	350	—
Portugal	—	—	—	—	69	—	—	—	69	—
Saudi Arabia	—	—	535	—	900	—	—	—	1435	—
Spain	84	—	30	—	288	220	—	—	402	220
Sudan	—	—	800	—	—	—	—	—	800	—
Sweden	186	—	—	—	—	—	—	—	186	—
Tanzania	—	—	—	—	678	—	—	—	678	—
Thailand	480	480	—	—	235	—	—	—	715	480
Tunisia	329	—	—	—	—	—	—	—	329	—
Turkey	105	62	670	—	—	—	—	—	775	62
United Kingdom	820	308	172	—	328	—	—	—	1320	308
USSR	8790	1500	1100	330	506	—	1450	—	11846	1830
Venezuela	85	—	—	—	—	—	—	—	85	—
W. Germany	360	—	85	—	30	—	—	—	475	—
Yemen	—	—	375	375	—	—	—	—	375	375
Yugoslavia	530	—	—	—	—	—	—	—	530	—
Zaire	—	—	—	—	205	—	—	—	205	—
Zambia	—	—	—	—	380	—	—	—	380	—
Grand Total	**54465**	**9456**	**19035**	**5293**	**8931**	**1309**	**2138**	**—**	**84559**	**16058**

**Iran data not included.*

Number one area in total miles is Europe, with 15,319 miles total of which 1981 miles are under construction. In the number two spot is Canada, with 14,643 miles planned or underway, and 866 actually being built. South America ranks third in total planned or underway mileage with 11,929 miles of which 2177 miles are being built, followed by the Middle East where 7739 miles are planned and underway, with 2307 actually under construction. Africa follows with 7171 miles planned/underway, and is the busiest pipeline area with 2440 miles presently being installed.

Russia has 11,846 miles planned/underway, with 1981 miles reported to be under construction, while members of the Eastern Bloc countries have 1715 miles planned/underway and 535 miles being built. The Peoples Republic of China reportedly is planning 3400 miles of new oil and gas pipelines.

Across southern Italy in Calabria, Saipem crews lower-in a section of the mainland 48-in. gas line; gas will ultimately be transported northward to the Po Valley in northern Italy.

Tough going. Route of dual oil and gas lines in same ditch between Sydney and Newcastle in Australia required moving some big boulders. At right, in easier-to-dig farmland, the two lines have been lowered-in and await backfill.

Europe

Hard hit by continuing price increases for imported oil and a desire to find a replacement for oil, the Continent is placing increased emphasis on developing natural gas supply ... and that means more gas pipelines will be needed. With the demise of gas supplies from Iran to Russia strongly affecting planning of all nations involved, negotiations for new gas supply agreements are underway — especially since many current agreements will expire in 1983. Increased imports from Russia, from Algeria — by pipeline rather than in the form of LNG — and from the North Sea will result in expanded pipeline construction activity.

The negotiations have also revived the SEGAMO plans that would involve a 600-mile line from Algeria to Spain and France and require a crossing (to depths of 6000 ft) of the Mediterranean. The technology for such a line is available. A major question will be the willingness to assume the cost of installing such a line. SEGAMO would eventually require a total system of some 1800 miles of gas pipelines. The pipeline proposal is favored by Algeria, which no longer desires to export its natural gas in the liquefied (LNG) form.

Another "soft" proposal that continues to be discussed is a plan for a 3230-mile, large diameter (48 to 56-in.) gas pipeline originating in the Middle East that would transport now-surplus gas from the Arabian Gulf through Saudi Arabia, Iraq, Turkey, Greece, Yugoslavia and on through and to major north central European countries.

United Kingdom's plans for a major 590-mile gas "gathering" pipeline system in the North Sea would further reinforce the U.K.'s energy-secure position with respect to natural gas and oil. But there are questions about the $2.5 billion project because the current British government is reluctant to provide any major part of the investment, even though the system would add 25% to available gas reserves, and refuses to permit a consortium to have full control. A firm financed by private sector money may be formed to build and operate the line — provided it can come to terms with British Gas Corp., the state-owned monopoly.

British Gas Corp., however, is proceeding with its fourth major gas pipeline from St. Fergus and has underway the 280-mile pipeline running south from the Scottish gas terminal. Other U.K. activity includes a 132-mile, 16-in. natural gas liquids pipeline from St. Fergus to Mossmoran near Edinburgh, for Shell U.K.

In France, work is near completion on the Nozay-Beynes gas line that will transport gas to underground storage at the Beynes site. (*See article this issue on Nozay-Neuville section.*) Work planned in France includes some 500 miles of new gas lines in 1981-1983 by Gaz de France. A 350-mile, 42-in. oil line from LeHavre to the Rhine River is also planned.

West Germany's planned pipeline activity in the next two years includes some 400 miles of new gas pipelines and a 210-mile line from Emden to the Danish border.

Denmark's big new gas transmission and distribution system — totaling some 3220 miles — will get underway in

INTERNATIONAL PIPELINE CONSTRUCTION — BY AREAS

(Underway, Planned, and Proposed — September 1979) In Miles

	Miles of Gas Pipelines		Miles of Crude Oil Pipelines		Miles of Product Pipelines		Miles of Slurry Pipelines		Total Miles	
	Total	Underway	Total	Underway	Total	Underway	Total	Underway	Total	Underway
Europe	13648	1761	687	—	984	220	—	—	15319	1981
Africa	3234	872	1976	670	1961	698	—	—	7171	2440
Middle East	1443	672	4689	1635	1607	—	—	—	7739	2307
Asia, Japan, & Pacific	1937	480	1807	1095	535	—	171	—	4450	1575
Australia-N.Z.	1750	110	3	3	496	101	15	—	2264	214
Canada	9807	720	3738	146	1098	—	—	—	14643	866
Mexico & Central America	2710	1560	946	522	427	51	—	—	4083	2133
South America	8881	1246	1701	692	1205	239	142	—	11929	2177
Subtotal	**43410**	**7421**	**15547**	**4963**	**8313**	**1309**	**328**	**—**	**67598**	**13693**
USSR	8790	1500	1100	330	506	—	1450	—	11846	1830
Eastern Bloc	1065	535	188	—	112	—	350	—	1715	535
China	1200	—	2200	—	—	—	—	—	3400	—
Subtotal	**11055**	**2035**	**3488**	**330**	**618**	**—**	**1800**	**—**	**16961**	**2365**
GRAND TOTAL	**54465**	**9456**	**19035**	**5293**	**8931**	**1309**	**2128**	**—**	**84559**	**16058**

1981. (*See article this issue on the system's pipeline plans.*)

Spain's Enagas has placed into service its new gas transmission system from Barcelona to the Basque country *(see article this issue)* and plans to build an 84-mile, 24-in. gas line to Zaragoza for $71 million.

Portugal's major pipeline project in the planning stage is a 69-mile products line.

Greece has a 70-mile undersea gas pipeline being planned to bring gas from Italy to Corfu Island.

Norway currently is studying plans to move natural gas from its extensive reserves at Statfjord Field in the North Sea — with the 600 + mile line to continental Europe the principal consideration; alternatives include a 250-mile line to Scotland and a 220-mile line to Norway. The U.K., though, already has a gas surplus, and Norway's principal use for natural gas would be as boiler fuel — an expensive alternative.

Sweden's major pipeline proposal, in the planning stage, is a 186-mile gas line.

Africa

Algeria remains the hotbed of pipeline activity in North Africa with over 3800 miles planned/underway — including three major gas pipelines and three major products pipelines in the design/planning stages; some 1960 miles of lines are currently being laid. Recent completions include major Hassi R'Mel-to-Arzew lines and the Algerian section of the Trans-Mediterranean gas line.

Libya's pipeline activity increased measurably in recent months as Arabian Gulf Exploration let contracts for 380 miles of various size lines to service the Messla oilfield; contract was awarded to Nippon Kokan K.K. and Marubeni Corp.; Zakhem International will build the pipelines.

Tunisia's state-owned electric and gas utility operation, STEG, is planning a new 248-mile gas pipeline system that will provide gas supplies to major Tunisian cities. The Tunisian section of the Trans-Mediterranean gas pipeline has been built ahead of schedule.

Sudan's major oilfield find near Abu Gabra is considered the forerunner of a suggested 800-mile oil pipeline from that point to Khartoum and on to Port Sudan.

In Zaire and Tanzania, major products pipelines continue to be studied. The Zaire proposal involves 200 miles of 20-in. line while the Tanzania project embraces some 678 miles of line from the Zamia border to interior areas.

Middle East

With completion of the east-to-west Petroline 48-in. oil line to Yanbu and the parallel Aramco natural gas liquids line, emphasis on pipeline activity in Saudi Arabia has turned to the major oil and gas/gas liquids gathering systems planned for the eastern oil fields. That includes some 500 miles of crude gathering lines and 900 miles of gas/gas liquids lines.

Abu Dhabi's offshore Zadco system, involving 746 miles of 4 to 48-in. pipelines in the Upper Zakum field, is underway and will be in the works until 1982. Abu Dhabi National Oil Co. (ADNOC) also has 140 miles of line under construction onshore.

In Oman, the 276-mile oil pipeline built by Dodsal GmbH has been completed (*see article this issue*). Planned are another 650 miles, including 140 miles of gas line and 510 miles of oil lines.

Iraq's pipeline ventures include a 684-mile LPG line from Kirkuk to the Mediterranean, scheduled to get underway in late 1980 or early 1981, a 290-mile 20 and 22-in. gas line from Kirkuk to Baghdad, a planned 775-mile, 48-in. oil line from Kirkuk to Tartus on the Mediterranean, and a planned 750-mile gas line to Tartus from North Rumaila.

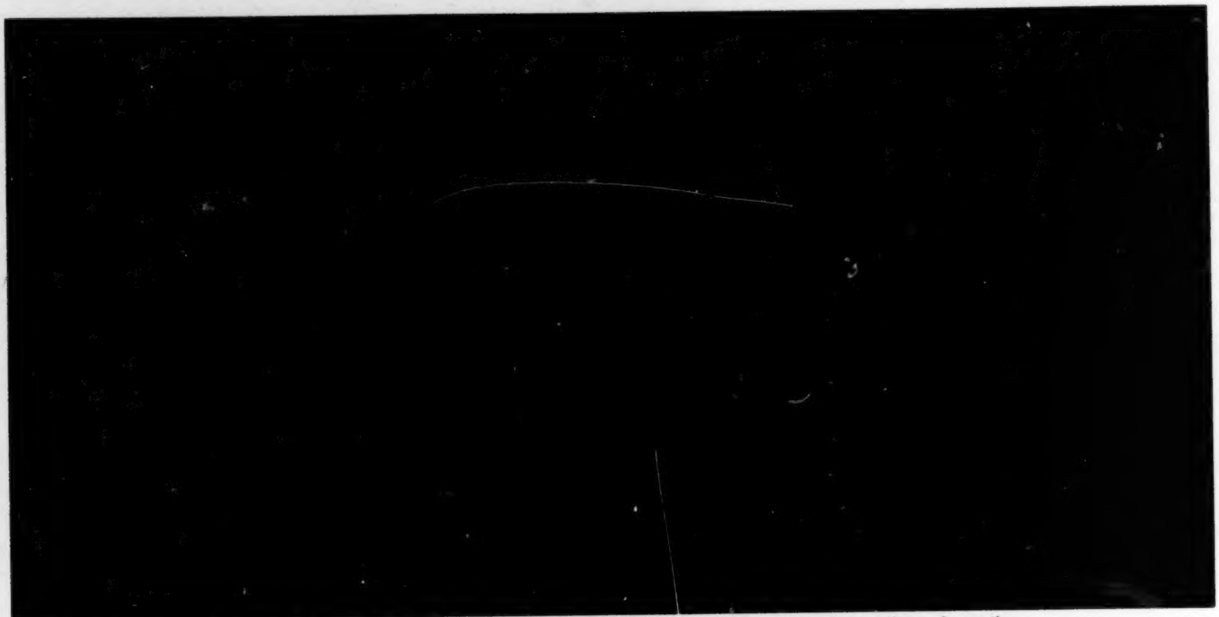
Turkey has ready for building a 270-mile oil pipeline for the Turkish Petroleum Co. between Dortyol and Kirrikyale. Contracts may be awarded in late 1980.

Southeast Asia

Thailand's Petroleum Authority of Thailand (PTT) has underway the 371-mile gas line from offshore platforms in the Gulf of Thailand to near Bangkok. Work on the 266-mile, 34-in. offshore line began near Sattahip with the pulling ashore of the first section of the sealine. Onshore, construction crews began at the landfall and moved north to install the 105-mile, 28-in. landline. The natural gas will supply electric power plants near Bangkok, the capital city.

In Malaysia, engineering is proceeding on the 84-mile, 36-in. offshore gas line that will transport gas from the offshore Luconia gas field to the Bintulu LNG Complex on Sarawak, where a $1-billion LNG facility is being erected. The LNG — 6 million tons per year — will be shipped to Japan.

India has 591 miles of pipelines in the planning stages, and if efforts to find increased oil and gas supplies — onshore and offshore — are successful, will be building a substantial



Coating gang moves uphill during work on pipeline expansion of the Gas del Estado system in southern Argentina.

number of new pipelines in the next two decades.

Pakistan, with 2650 miles of pipelines planned/underway, will complete nearly 1100 miles in the coming months, bolstering the national oil and gas transportation system.

China, anxious to expand its energy supply, reportedly is planning some 1200 miles of gas pipelines to serve industry in areas adjacent to its major gas fields, and 2200 miles of oil pipelines to transport crude from producing areas to consumption areas, where new refineries would be built.

Australia, New Zealand

Pipelining in Australia in the 1980's will be the best ever, industry experts say, if a worsening state of labor relations on pipeline jobs can be solved. Plans for construction of some 2070 miles of pipelines are on the boards; principal projects are an 84-mile, 40-in. offshore gas line from Dampier to the Northwest Shelf gas fields; a 932-mile 24 to 32-in. gas line from Dampier to south of Perth; a 118-mile, 10-in. gas line from Dampier to Pilbara, and a 350-mile, 14-in. gas liquids line from Moomba to Redcliff to supply a proposed petrochemical plant in far South Australia.

New Zealand, with gas flowing from the Maui field, plans to use gas to make methanol and convert that into motor fuel for the nation's trucks and automobiles. Bechtel and Mobil Oil are working out the details; when built, the plant will require more pipelines. Other pipeline plans include a 93-mile products line from Marsden Point refinery to Auckland, and Natural Gas Corp. of New Zealand is studying plans to build 100 miles of 6 thru 16-in. transmission lines to serve new communities with gas.

Mexico, Central America

Mexico's Petroleos Mexicanos (PEMEX) has embarked on a major pipeline program designed to transport natural gas and refined products to all of the major population centers in that nation. Current pipeline plans involve 3889 miles of all types of pipelines, and 2153 miles are under construction, making Mexico the fourth most active pipeline area in the world.

Only other significant pipeline planning activity in the area is that by the Honduras Government to build a 160-mile oil pipeline between the Atlantic and Pacific Oceans across the Honduras Ismuth. The world's current oil surplus has delayed work on the project.

South America

Argentina's Gas del Estado has its Central-West pipeline system under construction (*see article this issue*) with initial work on the 1084-mile system soon to expand as work gets underway on the mainline north from the Neuquen area to Beazley. Another 1417 miles of pipelines are planned throughout Argentina.

Bolivia and Brazil continue to study plans to build a 1900-mile, 24 and 30-in. line to transport gas.

Brazil expects to increase its oil and gas supplies materially with development of the Campos Basin offshore fields where work will begin in December on 340 miles of offshore oil and gas pipelines. Onshore, 309 miles of pipeline will be laid as part of the Campos development.

Colombia's pipeline activity includes 118 miles of 12 to 16-in. line for Ecopetrol, with work to begin in late 1980. Another 500 miles of 20-in. gas line are planned.

Chile's pipeline plans involve some 564 miles of line, including a 112-mile, 30-in. line to supply gas to a proposed LNG facility at Cabo Negro.

Canada

Canada's pipeline fortunes revolve around four major points: one, building of the Alaska Highway Gas Pipeline Project, on which partial approval has been given—some 687 miles of prebuild in 1980 and 1981; two, export of surplus gas to the U.S., which requires considerable new lines, gathering systems, and loops on old lines; three, building of the "eastern" gas system to New Brunswick and Nova Scotia from Montreal, and, four, eventually bringing oil and gas southward from the Arctic regions to markets in southern Canada and the U.S.

Soviet Union

Russia's ministry of oil and gas has announced plans to eventually have seven 1000-mile, 56-in. gas pipelines operating between the Urengoiskoye fields and Chelyabinsk; two of the big lines are in operation and work may be underway on a third—leaving four to go in the next decade or so. Russian pipeliners are also building a 422-mile, 48-in. line from Mozdok to near Baku. Line would help supply gas lost due to the cessation of Iranian gas imports at Astara. Also underway is a 217-mile, 32-in. gas line between Vilinius in Lithuania and Kaliningrad on the Baltic. **P&GJ**

International Report

Denmark's 13,230 Km Gas System

by Hans Jørgen Rasmusen, *Vice President, Engineering and Operations,*

Construction of the first section of gas transmission pipeline in Denmark's ambitious 13,230 km (8220 miles) natural gas transmission and distribution system will get underway in 1981, to be followed in 1982 and 1983 by construction of other major segments and a 230 km offshore pipeline to North Sea production.

Intensive planning and design for the far-reaching system during 1980 follows approval in 1979 by the Parliament of the Natural Gas Plan, result of almost 10 years of preparatory work that began with discovery of gas in the Danish and southern Norwegian North Sea shelf in the late 1960's.

Early attempts to bring natural gas to Denmark were through the state-owned Dansk Olie & Naturgas A/S when Ekofisk gas and later Frigg gas was offered for sale. Plans were made to land the gas in Jutland and route it to the continental market. These plans did not materialize, partly because of insufficient economic incentives.

In the early 1970's, knowledge of indigenous oil and gas reserves increased steadily as result of exploration conducted by Dansk Underground Consortium (DUC), whose partners are A.P. Møller, Shell, Texaco, and Chevron.

DONG was given first right of negotiation for purchase of gas found—and was required to develop plans to market and distribute the gas. More than $10 million was allocated to the various planning activities. The DUC Gas Report was submitted in March, 1978 and negotiations began.

Oil supply problems of 1973-74 and price instabilities of 1978 demonstrated the weakness of a high dependence on imported oil and made it clear that indigenous oil and gas supplies had to be exploited fully.

The Danish Market

The natural gas agreement between DUC and Dansk Olie comprises 55 billion m^3 to be delivered at rate of 2.5 billion m^3 per year, beginning in 1984, with a three-year build up period. Gas will be produced from fields now known as Tyra, Roar, Gorm, and Dan, of which the latter two are associated gas fields. The agreement provides for an increase in the annual production rate should reevaluation of reservoirs indicate recoverable reserves beyond 55 billion m^3. The current government estimate of proven and probable reserves is between 100 and 150 billion m^3.

Table 1 shows the overall primary energy demand as estimated in the energy plan of 1979. The table shows the high overall dependence upon oil as well as the conservation efforts made and planned.

A substantial part of the natural gas will substitute for heating oil in domestic and industrial markets, whereas baseload uses such as power generation will be almost nonexistent. This is because a substantial amount of the power generation uses coal.

Apart from load factor problems created by the high heating content market, build-up poses another substantial task because the current gas consumption amounts to only 5% of the expected plateau-rate.

The market strategy foresees that the first year effort in a particular area will be to connect the large consumers, i.e. industry and district heating, which subsequently may be operated as interruptable customers. The domestic consumers will be picked up during a 4-to-6 year period.

Much effort is currently being put into early market developments. New housing projects which are located in planned natural gas areas are to be temporarily supplied from small LPG facilities. Various measures are taken to avoid large and costly replacements of old domestic oil burners and tank installations, which will have to be replaced or converted to gas a few years hence. Various regulatory requirements are being introduced in order to ease the transition.

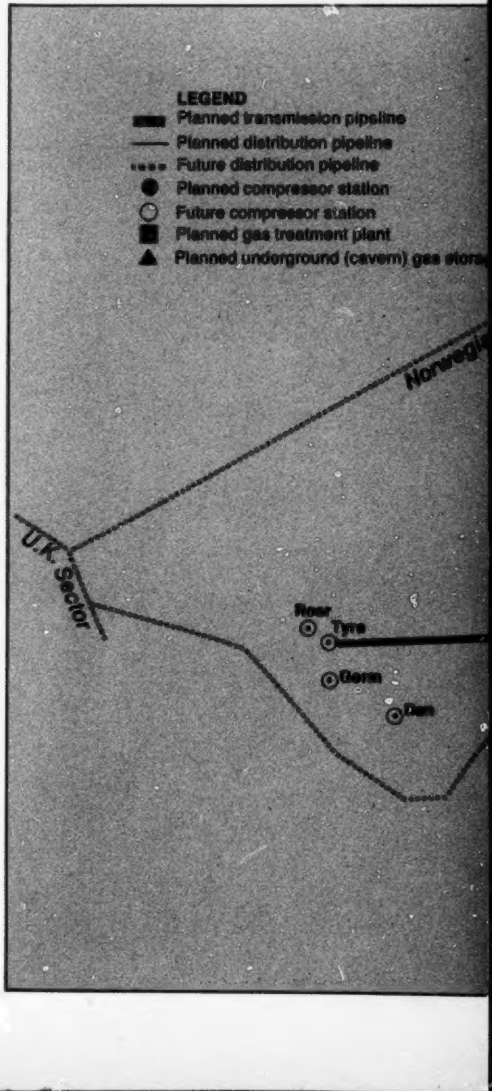
A particularly important measure in the market development is an agree-

TABLE 1.
Primary Energy Demand in Denmark

10^6 x Gcal	1972	1975	1978	1985	1995
Oil	171	148	151	116	119
Coal	13	21	41	45	51
Wood, sun, waste, etc.	1	2	2	5	10
Imported electricity	2	1	1	—	—
Natural gas	—	—	—	25	40
Uranium	—	—	—	—	30
Total	197	172	195	191	250

TABLE 2.
Principal Energy Use in Denmark
(Natural gas contribution percent shown in brackets.)

Consumption (gross) 10^6 Gcal Total country	Electricity production	Home & office heating	Processing	Transport	Total
1978	58	74	27	36	195
1985	62(3%)	61(26%)	28(25%)	40	191
1995	82(3%)	74(29%)	40(40%)	54	250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Planned distribution pipeline
Future distribution pipeline
Planned compressor station
Future compressor station
Planned gas treatment plant
Planned underground (cavern) gas stora
Norwegi
U.K. Sector
Roar
Tyra
Gorm
Dan

To Get Underway In 1981

Dansk Olie & Naturgas A/S, Copenhagen, Denmark

ment signed between Ruhrgas AG and DONG in 1979. The contract with Ruhrgas provides for a possible "soft" start-up of the natural gas supply in 1982-83, with limited supplies for 3 years from 3 to 700 million m^3 annually. A "soft" start-up (in South Jutland and Funen) would result in a better distribution of investments and permit a more thorough training of employees.

The Gas Organization

Under the 1979 energy plan, Dansk Olie & Naturgas A/S will purchase and transport gas at high pressure and will sell gas to five regional companies plus a limited number of large consumers.

The regional companies will operate a medium pressure network, normally at about 16 bar (250 psi). They may sell the gas further to municipal distribution companies or distribute directly to the end-users, depending upon local arrangements.

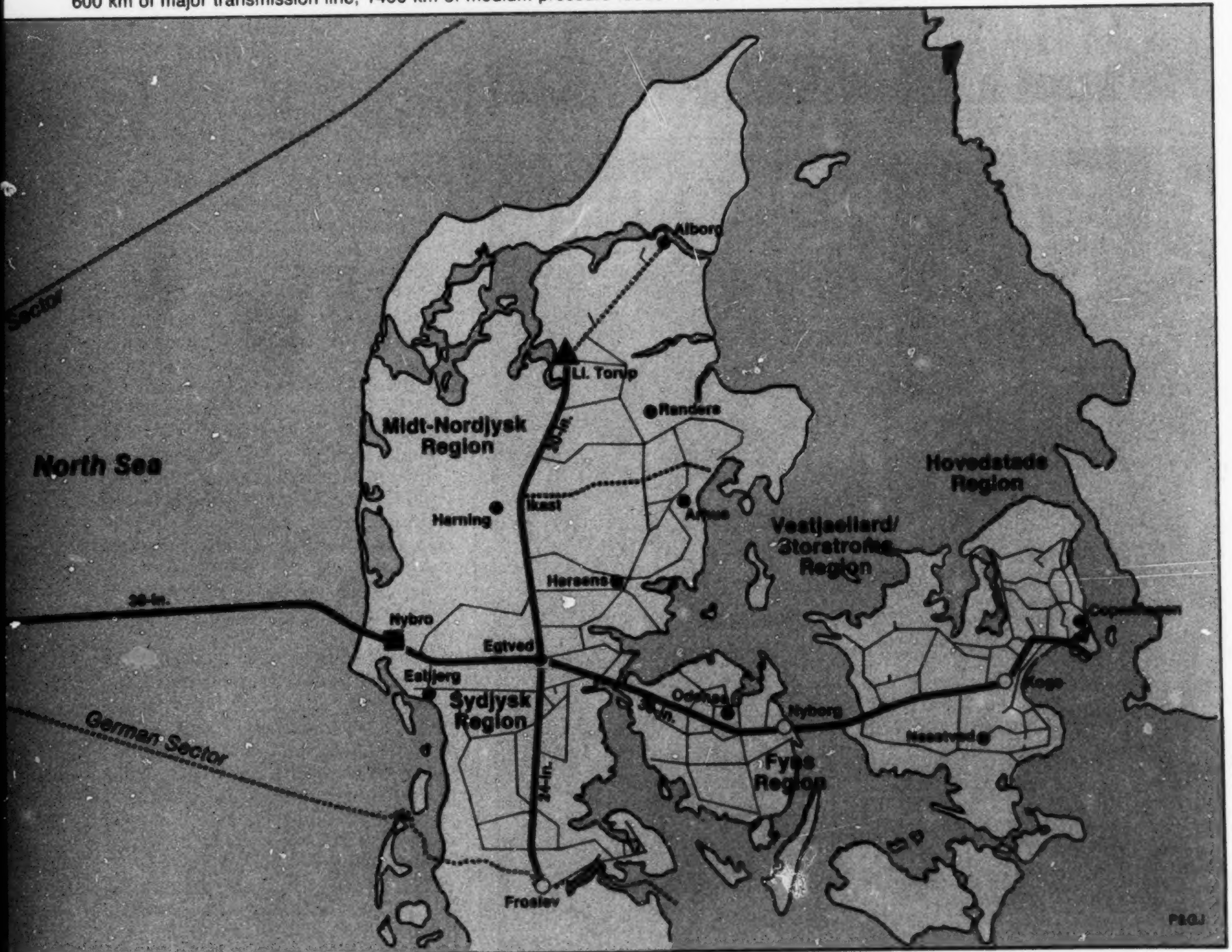
Approximately half of the initial annual gas volume will be sold in the metropolitan area near Copenhagen.

The distribution network in central and northern Jutland may not be developed until additional gas is made available. The main task at all levels will initially be to design and construct the transmission and distribution system. The regional and municipal companies will however also have to engage in sales activities at an early date.

Organizational development not only involves forming companies but also a substantial recruitment and training staff. Beginning with 10 people in 1977, the DONG staff increased to 75 by early 1980, and will total 250 by 1984. A similiar but slightly delayed trend is being experienced at the regional level.

Engineering design and construction will be performed by outside engineering companies and contractors. The engineering design is performed by Naturgasgruppen, a consortium of Danish consulting engineers — Dangroup, Oilconsult, Mogens Balslev, and Dansk Hydraulisk Institute, assisted by Pipeline Engineering (Germany) and Global Engineering A/S.

Extent of new gas transmission and distribution system in Denmark is shown on map—system includes 230 km of North Sea delivery line, 600 km of major transmission line, 1400 km of medium pressure feeder lines, and 11,000 km of distribution lines.


Sector
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Ll. Torup
Randers
Midt-Nordjysk Region
30-in.
Herning
Ikast
Arhus
Horsens
Hovedstade Region
Vestjaelland/ Storstroms Region
30-in.
Nybro
Egtved
Esbjerg
Sydjysk Region
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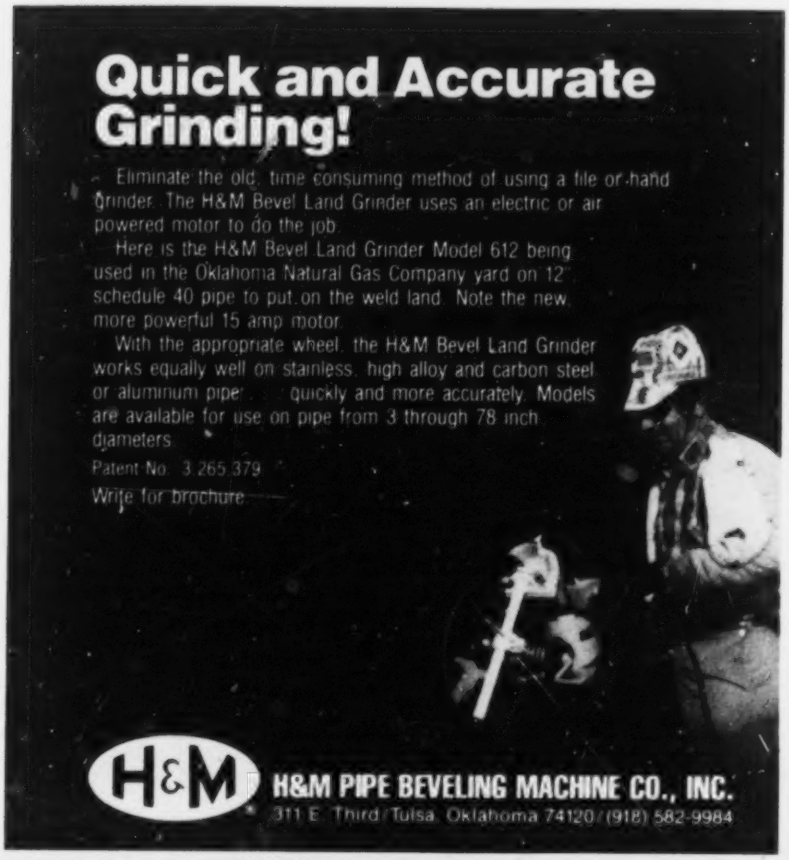
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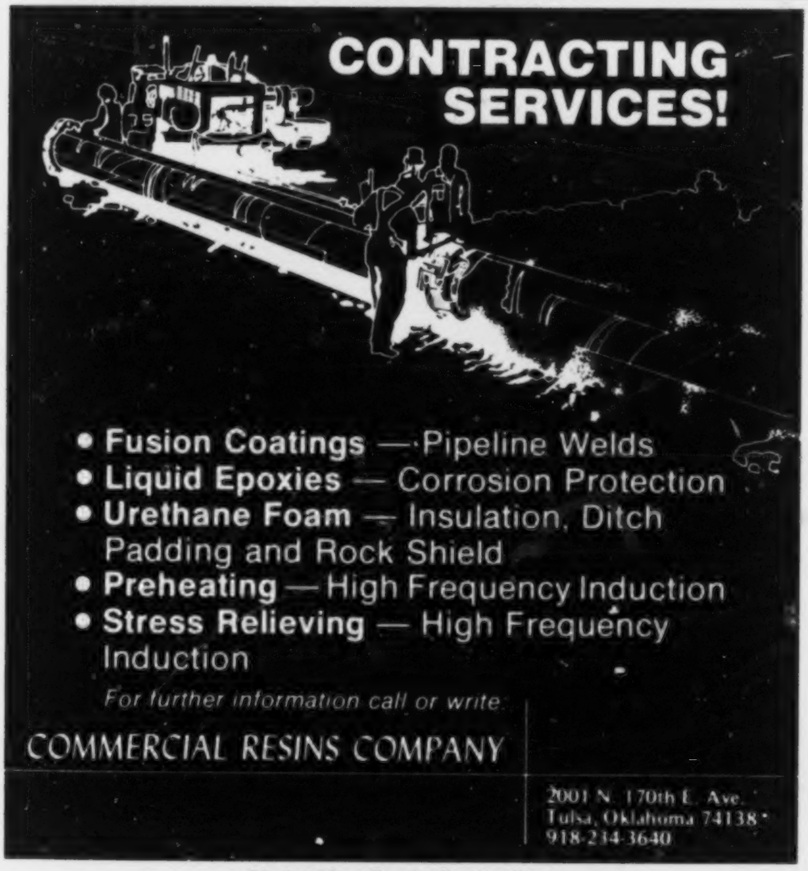
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Every effort is being made to ensure that Danish firms — to the extent that they are competitive as regards price and quality — are able to participate in the design and construction phases.

The planning and construction organization for the transmission system, comprising administration, design, tendering, supervision, and commissioning, etc., will be managed directly or through consultants by DONG.

Technical Design

The virtual absence of existing gas distribution in Denmark permits natural gas to be introduced without design constraints introduced by the problems of conversion of town gas networks.

Three pressure levels will be used:

- 80 bars (1176 psi) for the DONG A/S transmission system.
- 16 bars (235 psi) for the Regional distribution systems.
- 4 bars (59 psi) for the street mains.

The 4 bar street mains distribution system offers several advantages over conventional European low pressure systems. Piping can utilize small diameter polyethylene pipe, normally supplied on reels. Installation can often be made by plowing techniques, particular in suburban areas. PE pipe is not subject to corrosion, which reduces maintenance considerations.

The 4 bar distribution system does require installation of small regulators outside house installations. These regulators will be combined with the meter installation. Total length of the 4 bar system is estimated at 11,000 km (6835 miles), including service lines.

The 16 bar pressure level was selected with specific objectives in mind:

a) This pressure level is below the critical pressure of the dew point curve for the sendout gas. Liquids are not expected to form in this network and facilities for routine pigging can be eliminated.

b) Pressure reduction to the 4 bar level can be accomplished without heating the gas, thus simplifying design and operation of these regulator stations.

Total length of the 16 bar system is estimated at approx. 1400 km (870 miles).

The regional companies may have to accept a limited responsibility for peakshaving of a short duration nature. The most probable means will be by LPG-air mixing stations operated in connection with the 16 to 4 bar pressure reduction. These facilities may also provide a valuable spare gas source in case of short falls in the primary sources.

The DONG A/S transmission system will deliver natural gas from gas fields in the Danish sector of the North Sea to markets throughout Denmark, with interconnection to the German gas network at the Danish border.

The production platform in the North Sea will be connected by a 230 km, 30-in. offshore pipeline to the west coast of Jutland. Before the North Sea gas can be sold to the consumers, however, it must be treated and small amounts of hydrogen sulphide removed and subjected to various other processes in order to ensure a uniform, high quality. Treatment will take place in a gas treatment plant at Nybro, northwest of Esbjerg.

The natural gas system is sized to accommodate the expected variations in consumption. Maximum consumption is calculated to occur at a mean daily temperature of −14 C. Statistically this, or lower temperatures, will only occur once every 15 years. The heating installations of most consumers are sized for −12 C.

The onshore transmission system will further be sized so that approximately 6 million m^3 per day capacity can be provided for transit of gas on behalf of Swedegas AB of Sweden.

Capacity of the North Sea pipeline will be approximately 25 million m^3 per day based on normal gas composition. This capacity will accommodate abnormal gas compositions, especially during the first years of operation, and provide spare capacity for the transportation of gas from other discoveries.

Capacity of the gas treatment plant is 10 million m^3 per day, corresponding to the maximum daily contrast supply rate; the design arrangement provides for ready extension of facilities to handle approximately twice that volume.

A major part of the fluctuation between summer and winter consumption loads is directly absorbed by changing the supply rate of the natural gas. The gas purchase contract provides for a maximum supply rate of approximately 1.6 times the annual supply rate, based on the average daily consumption at the start of the contract, decreasing over the life of the contract to approximately 1.2 times the annual average supply rate.

Over and above this level, the consumption will be equalized for significant periods by using gas from storage facilities, or by interruptibles.

Storage will be caverns in the salt deposits at Lille Torup in Northern Jutland, and will have an initial working capacity during phase 1 of 110 million m^3, which will be increased to 240 million m^3, and ultimately to 350 million m^3.

During the build-up period it is expected that a number of customer groups, primarily district heating plants, will take gas on the basis of agreements which permit interruption of supply.

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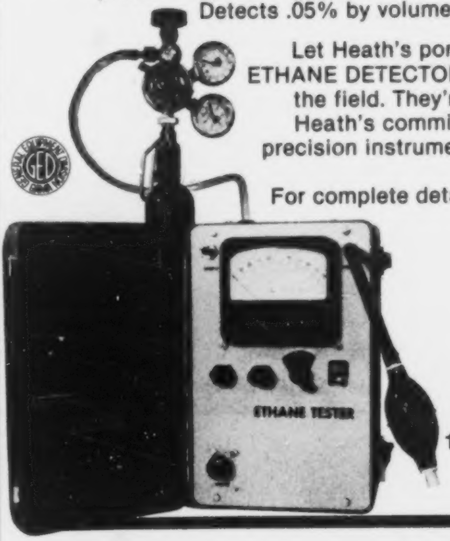

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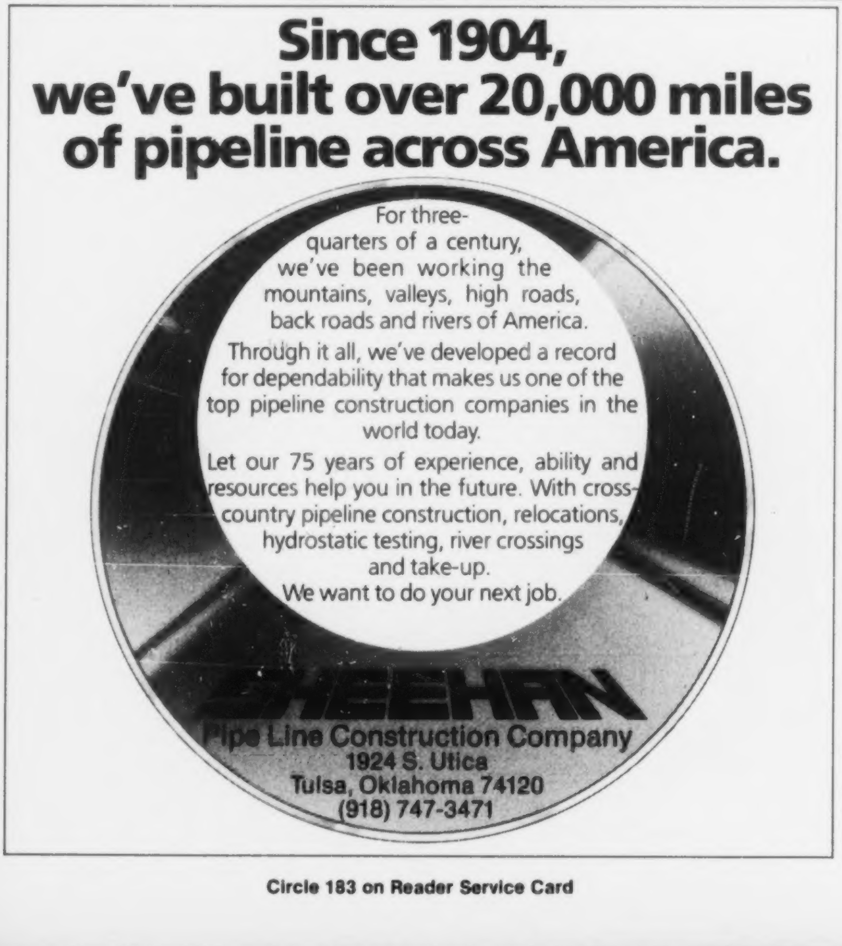
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Time Schedule

Plans to extend the existing gas distribution network in the Copenhagen area have been developed and some construction has commenced. The first LPG satellite units are being constructed during 1980.

Construction of the transmission system will begin in 1981 with the 24-in. Froslev-Egtved pipeline. This pipeline will be ready in the summer 1982, when the connecting DEUDAN pipeline extending from the German-Danish border to the existing German natural gas network will be ready.

The pipeline from Egtved east across Fyn island will be constructed during 1982, including the 1.2 km wide and difficult crossing of Lille Baelt begin in 1983. Construction of the 230 km long North Sea pipeline and the first two H_2S treatment trains at the gas treatment facility will also begin in 1982 to be ready for start-up in the summer of 1984.

The 25 km long crossing of Store Baelt between Fyn and Sjaelland will be constructed in 1983. That year will also see that start of substantial activity of Sjaelland, particularly in the Copenhagen area. Start-up of natural gas supply to Copenhagen is planned for summer 1984, following commissioning of offshore production facilities.

The Future

Even before the first natural gas flows through the new Danish system, plans are being drawn to extend the market and the transmission services.

In February 1980 Swedegas AB signed a transportation agreement with DONG. This agreement provides for transportation of up to 6 million m^3 per day. Gas sources are not yet known, but the capacity will help Sweden in its plans to introduce natural gas. The transportation agreement is supplemented by a gas sales agreement through which DONG will make approximately 200 million m^3 of gas available for Swedegas AB.

The full extent of the indigenous Danish resources are not known, but it is likely that 1 to 2 billion m^3 of additional gas will be handled by the system in the late 1980's.

The excess capacity of the Danish North Sea pipeline provides a suitable means to land gas from smaller reserves in the vicinity of the Danish fields or to be part of a system for transport of North Sea gas to the European markets. While all of the above prospects are still in the development stage, they do however serve to indicate the longterm developments to which the Danish natural gas system may contribute.

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